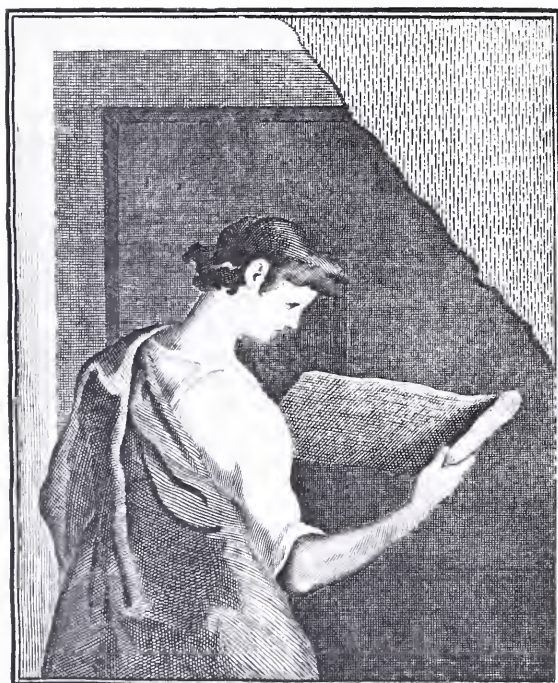




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P A P E R S

READ AT

The Royal Institute of British Architects,

SESSION 1853—54.

USUI CIVIUM, DECORI URBIUM.

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INDEX.

TITLE.	AUTHOR.	DATE.	PAGE.
Some Remarks upon the Buildings of Lille in France; and a description of a fine Collection of original Drawings by the Great Italian Masters.	T. L. Donaldson.	Nov. 14th, 1853.	1— 10
On the application of Painted Glass to Buildings in various styles of Architecture.	C. Winston.	Nov. 28th „	11— 25
—— Discussion on the same continued.	—	Dec. 12th „	27— 30
Communication from the Honorary Secretary for Foreign Correspondence	T. L. Donaldson.	Jan. 9th, 1854.	31— 35
Description of the French Method of constructing Iron Floors.	H. H. Burnell.	Jan. 9th „	36— 40
—— Discussion on the same continued.	—	Jan. 23rd „	41— 51
—— Discussion on the same continued.	—	Feb. 6th „	53— 61
—— Discussion on the same concluded.	—	Feb. 20th „	63— 74
A Brief Account of the Louvre and Tuileries, Paris; with a general description of various projects for their completion	T. L. Donaldson.	March 6th „	75— 86
On the Drainage of Buildings and Streets in the Metropolis.	W. A. Boulnois.	Mar. 20th „	87— 98
—— Discussion on the same continued.	—	April 3rd „	99—106
On the Open Spaces of our Metropolis.	S. Angell.	May 8th „	107—121
Discussion on the Drainage of Buildings and Streets in the Metropolis concluded.	—	May 15th „	123—128
On some recent Discoveries at Fountains Abbey	Earl De Grey, K.G.	May 29th „	129—136
On the influence of some External Agents on the Durability of Building Materials.	Geo. R. Burnell, C.E.	June 5th „	137—153
On Architecture as represented in Pictures.	H. Twining, Esq.	June 12th „	155—159
On the Topography and Antiquities of Constantinople.	Rev. R. Burgess, B.D.	June 26th „	161—172

SOME REMARKS UPON THE BUILDINGS OF LILLE IN FRANCE, AND A DESCRIPTION OF A FINE COLLECTION OF ORIGINAL DRAWINGS BY THE GREAT ITALIAN MASTERS, BEQUEATHED TO LILLE, HIS NATIVE TOWN, BY THE LATE MONS. WICAR, DIRECTOR OF THE ACADEMY OF NAPLES; PARTICULARLY IN REFERENCE TO A SERIES OF ARCHITECTURAL SKETCHES ATTRIBUTED TO MICHAEL ANGELO. WITH ILLUSTRATIONS.

By T. L. DONALDSON, Honorary Secretary for Foreign Correspondence.

Read at the Ordinary General Meeting of the Royal Institute of British Architects, November 14th, 1853.

THE City of Lille has hitherto been more remarkable for the extent and strength of its fortifications, which were deemed a masterpiece of the great Vauban, than for its architectural monuments; for although its Hotel de Ville still retains some points of architectural and antiquarian interest, and some of the churches evince considerable elegance and skill in design, yet they do not boast any very remote antiquity, are not distinguished for their decoration, and its tallest spires and towers have been destroyed during sieges at various periods; the most disastrous of which was the nine days' bombardment by the Austrians in 1792, under the Prince of Saxe Teschen, which brought down some of its loftiest and proudest monuments.

There are two "*Places*," nearly together; one of considerable size, the other much smaller. Some of the streets are of tolerable width, and run in straight lines to the city gates. Many of the houses are attributed to the times when the Spaniards ruled the country, in the 16th and 17th centuries, and exhibit signs of affluence and ease; the fronts being much decorated with pilasters, enriched capitals, capriciously decorated doors and windows of the Italian taste and of heavy proportions.

There are six parish churches, three of which are Gothic. S. Maurice, the Cathedral, is remarkable for its five aisles of equal height, divided by cylindrical pillars. The end is apsidal, the sides being formed into polygonal chapels, like those at Westminster Abbey. The effect of the various vistas of the interior is very striking, and the combination of the several parts produces most pleasing and effective groupings. The Church of S. Sauveur had once a noble stone spire with pierced tracery, but the cannon balls of the Austrians brought it to the ground in 1792. The Church of S. Catherine, a Gothic structure, seemed to me peculiarly adapted for one of our churches, as it consists of a nave and side aisles divided by cylindrical pillars, which being twelve diameters apart, offer little obstruction to the sight. The Church of the Magdalen, of Italian design, has a central circular hall as it were, with a circular aisle around it, from which radiate the choir in an easterly direction, and corresponding chapels to the north and south, with considerable effect. The two other churches are those of S. André, and the Jesuits', on the usual Italian model, divided by columns and piers; spacious, airy and simple, and on a noble scale. In the last of these considerable appearance of extent is given by the end of the side aisles being painted to represent a distant vista: by this expedient great lightness of effect is given, and the deadness of a blank wall avoided, although it must be considered to be somewhat a meretricious expedient. There are several modern buildings of considerable importance, among which is a Lycée, of great extent of plan, now in course of erection, and the Hotel de Ville, formerly the Palais de Rihour. So much of the old part of this edifice as now remains, is of the Gothic style; it was originally enlarged and completed in 1430, by Philippe le Bon, Duke of Burgundy and Count of Flanders, whose device of the flint and steel is gracefully introduced on the staircase, in the ornaments of the groined vaulting of the interpenetration character, the mouldings of which are very curiously interlaced. Besides this staircase there are few remains of the ancient fabric, which is now being superseded by the spacious and noble structure, rising from the designs of Mons. Benvignat. But there is still an old lofty hall with a groined ceiling, called

the Salle du Conclave, which also contains some fine paintings, well combining with its architecture and fittings. Mons. Benvignat and the authorities have every disposition to retain these striking features of the old Palais, associated as they are with many historical circumstances, such as the holding the second chapter of the Golden Fleece in 1431; the meeting of Charles V. and our Henry VIII. in 1541, and with brief residences of Louis XIV. in 1670, and of Louis XV. in 1744.

The old Palais de Rihour was so generally dilapidated, that a few years ago it was determined to take it down, and erect on the site a new Hotel de Ville; and the work was confided to Mons. Benvignat, who has designed it on an ample scale, with lofty storeys, grand vestibules and halls, spacious staircases, and well lighted picture galleries. The columns are of the blue lias formation procured from Belgium near Tournay, the shafts being monoliths, and the pedestals and bases also in single blocks of considerable dimensions.

The Museum, the City Library, and Municipal Offices are contained within this fine building. You will remember that on a former occasion, when I described to you the public institutions of Caen and Arras, I alluded to the noble munificence and public spirit with which the principal cities of France were endowed with institutions on a grand scale, and of an useful and intellectual character: and it must be acknowledged that, however detrimental the octroi may be considered to the commerce of a place, its revenues have procured to the leading cities of France, institutions and edifices which we may well envy them; and we can hardly hope that the merely permissive character of recent enactments in this country can ever realise such results as have been effected in France. A majestic staircase, adorned in part with casts from our Elgin marbles, leads to the Public Museum of Lille, which consists of seven rooms of noble dimensions, four of them containing some very creditable productions of ancient and modern painters, and copies of some pictures by Paul Veronese, Raphael, Rubens, Vandyke, and other leading masters.

But the most precious portion of these works of art is a collection containing about 1200 original drawings; 197 attributed to Michael Angelo, 3 to Leonardo da Vinci, 68 to Raphael, 13 to Masaccio, 6 to Andrea del Sarto, 9 to Bandinelli, 1 to Paolo Veronese, 1 to Perugino, 1 to Gian. Bellino, 8 to Annibale Caracci, 2 to Coreggio, 17 to Carlo Dolci, 10 to Fra Bartolomeo, 15 to Francia, 8 to Guercino, 5 to Ghirlandajo, 3 to Giulio Romano, 1 to Palma, 5 to Parmegiano, 6 to Poussin, 2 to Tintoretto, 8 to Titian, 2 to Albert Dürer, 3 to Lucas de Leyde, 1 to Rembrandt, and 1 to David.

Many of these are apparently first sketches of pictures, which have since acquired the highest reputation, and shew the gradual steps by which the great masters progressively improved the rude embryos of their first thoughts; and in order to compare the original ideas with the finished works, there are engravings of the pictures as completed. Some are in pencil, others in black or red chalk, and several in bistre. A most lovely model in wax, attributed to Raphael, of a female head the size of life colored to nature, the contour, pose and expression of which recal the perfection of Greek art, rivets the attention of every visitor. It is fractured in the neck, and evidently is of so frail a nature that, however anxious has been the desire to take a cast, the success seems too hazardous to justify the attempt. The drapery covering the bust, and the pedestal are of terra-cotta of a later period. I consider this the gem of the collection.

To architects the most precious portion of the drawings, is a series of 185 sketches of architectural subjects attributed to the pencil of Michael Angelo. They are now mounted in glazed frames, so arranged as to shew both sides of the sheets, as they originally were in a sketch book, and with drawings on both sides, the size 8 inches by 5. They are generally drawn in bistre, and the plans tinted with a light shade of that color. To some there are dimensions; others have the words *a dischretione e nō e misurato*: sometimes the word *anticho* is added. They consist of plans, sections, details, and some few elevations, of various ancient and modern buildings. Among the former are the arches of Titus, Septimius Severus, Janus, and Constantine, at Rome; of Augustus at Pola, in Istria; a plan and details of the Coliseum. Some seem to be plans of *Ædicula* or tombs, like those then abounding in the Campagna; and I find No. 439 to be identical with the plan of plate 24 of Montano's *Scelta di varii Tempietti Antichi*. There is a sketch in

pencil of the drum, under the cupola of S. Peter's at Rome, as designed and executed by Michael Angelo, with the abutment piers and coupled engaged columns, instead of the continuous colonnade of previous designs, whether by Bramante or S. Gallo; and above are some loose lines in pencil indicating the dome, though not very definitely, and more like the Pantheon than S. Peter's. There are several drawings of the parts of the Church of S. Pietro in Montorio, which was designed and built by Bramante, the cotemporary of Michael Angelo and uncle of Raphael; and many sketches of the Baptistery at Florence, of the Lantern of S. Lorenzo, a plan of the Chiesa degli Angeli by Brunelleschi, and other buildings in that city, and particularly of the Medicean Library, designed and almost entirely executed by Michael Angelo, but completed by Vasari, to which I shall again more particularly allude. There are sketches of vases, arabesques, pulpits, and groups of trophies of ancient Roman armour.

During the short period of time that I was enabled to devote to the careful examination of these drawings, I sketched off some of the plans, which I have had since drawn out to about twice the size of the originals, in order to give an idea of the interesting character of the series. One of these, enlarged more than the others on account of its importance, gives a restoration of the Ruin in the Campo Vaccino, known as the Temple of Peace, or as our friend Mr. Burgess, and other antiquaries, call it, the Basilica of Constantine. It gave rise to some discussion, when Mr. Burgess favored us during the last Session with his instructive paper on the ancient Basilica and early Christian Temple. The sketch contains these original remarkable words upon it in Italian: "(questa una pianta d'una chiesa moderna no so di chi sia mano)"; "this is a plan of a modern church by I know not what hand." Now the restoration of this ruin, as you are aware, has puzzled antiquarians and architects from the time of Serlio to that of Palladio, and down to the present period. Its name, its destination and its plan have been a constant enigma: but it appears stranger still, if Michael Angelo be the author of these sketches, that he should copy the idea of another, call it a modern church, and say he knew not by what hand, when from his constant residence at Rome, he must have had a thorough knowledge of the pile, whose three arches rise with such majestic grandeur among the ruins of the Campo Vaccino, and his eye, familiar with the building, must have recognized at once an adaptation and not a "*chiesa moderna*." A curious coincidence is, that he himself, whether before the date of this sketch or after it is impossible to say, converted a similar hall in the Baths of Diocletian to the purposes of religious worship. The church, a majestic one from its size and simplicity, is known as the Madonna degli Angeli, and is interesting also to artists as containing the tombs of Carlo Maratti and Salvator Rosa; the grand hall is 198 ft. long by 84 ft. wide, independently of the end chapels, which give an additional length of 65 ft. each, making a total length of 328 ft. These measurements were taken by Mr. Hardwick and myself, when we were together in Rome in 1818.

This sketch suggests many remarkable considerations. It omits the large lateral niche; it fills in small columns between the large arches of the nave, and thus decidedly separates the central nave from the side aisles; it adds small columns to the niches, as though each had a tabernacle, as in the Pantheon, a very probable conclusion. But the most important circumstance is the addition, at one end, of a noble portico of large proportions; where from the time of Serlio to the present period, comprehending Palladio and Canina, the space is supposed to be occupied by a paltry arcade. As such a feature is irreconcilable with the broad treatment of the rest of the edifice, and considering the arcade to be a construction of more recent times, it seems more consistent with the true spirit of the original design to give it a more dignified façade, than that of Palladio or Canina, so as to be accordant with its size and disposition, maintaining its importance with the Temple of Venus and Rome immediately adjacent, and the other magnificent buildings of the Roman Forum, to which it is contiguous.

Our friend, Mons. Hittorff, to whom I sent a copy of this sketch, has called my attention to the similarity between the plan of this portico, and that of a portico to S. Peter's attributed to Michael Angelo; they are placed side by side on one of the illustrations now exhibited, the only difference consisting in the

number of the columns,—the one being for a tetrastyle, the other for a hexastyle portico, and the projection of the porticos being respectively two and three intercolumniations. But our distinguished Honorary and Corresponding Fellow, calls attention to another suggestion presented by the plan, which forcibly revives an early impression upon his mind, that the primitive plan of S. Peter's at Rome, as designed by Bramante, consisting of a simple Greek cross, and divested of its superfluous accessories, would seem to have been suggested by the plan of this ruin, with which in its main lines and features it palpably corresponds.

Such are some of the speculations, which arise from the contemplation of this plan and the startling words—“*chiesa moderna no so di chi sia mano.*”

I shall not perplex you nor myself by any lengthened speculations upon the real character and destination of this edifice. Its plan is wholly at variance with the type presented in any known temple of the Greeks or Romans: hence the name of Temple of Peace seems inappropriate. Its plan is no less discordant from the precepts of Vitruvius, or any other basilica in ancient Rome, hence the term Basilica of Constantine would remove it from the usual basilican canon; and experience does not teach us that the Romans of later times departed very materially or radically from established previous types. But its vicinity to the Domus Aurea of Nero makes me inclined to consider it as a vestibule to that noble palace, partially saved from the conflagration, restored, added to by Maxentius, and possibly christened with a new name in periods much subsequent to its original erection.—And now *Requiescat in Pace.*

The next sketch, to which I invite attention, is that of the plan of the Vestibule to the Medicean Library at Florence. Those, who have visited that building, will remember the vestibule and its strangely planned flight of steps, leading up into the library: and they will recal the columns sunk in the walls, and other grotesque mixtures of heterogenous forms in the details, which fully bear out what Vasari says of Michael Angelo,* and who thinks to praise the master for having “composed a decoration of” what he calls, “a richer and more varied character than had ever before been adopted, either by ancient or modern masters. The beautiful cornices,” says he, “the capitals, the bases, the doors, the niches, were all very different from those in common use, and from what was considered *measure, rule and order by Vitruvius* and the ancients; to whose rules *he would not restrict himself.* But this boldness on his part has encouraged other artists to an injudicious imitation, and new fancies are continually seen, many of which belong to ‘*grottesche,*’ rather than to the wholesome rules of ornamentation. Artists,” continues Vasari, “are nevertheless under great obligations to Michaelagnolo, seeing that he has thus broken the barriers and chains, whereby they were perpetually compelled to walk in a beaten path, while he still more effectually completed this liberation, and made known his own views in the Library of San Lorenzo, erected at the same place. The admirable distribution of the windows, the construction of the ceiling, and the fine entrance of the vestibule, can never sufficiently be extolled. Boldness and grace are in the work as a whole, and in every part: in the cornices, the corbels, the niches for statues, the commodious staircase and its fanciful divisions—in all the building, at a word, which is so unlike the common fashion of treatment, that every one stands amazed at the sight thereof.”

The Medicean Family having collected a vast quantity of very fine manuscripts of the classic authors from the Greeks, who had been driven from Constantinople, and from other sources, were anxious to provide a receptacle worthy so rich a treasure.† Clement VII, one of the Medicean Popes, was desirous of establishing memorials to his fame in sculpture, painting and architecture, as Leo and his other predecessors had done. This was about 1625, and Michael Angelo was summoned to Florence to design the library, to be called that of San Lorenzo, with a new sacristy to the church, wherein the Pope proposed to erect the

* Vasari's Lives, translated by Mrs. Foster, vol. v. p. 272.

† Page 271.

marble tombs of his forefathers,* two to enclose the remains of the fathers of the two Popes, Lorenzo the elder and Giuliano his brother, with those of Giuliano Duke of Nemours, the brother of Leo, and of Lorenzo Duke of Urbino his nephew.

Eight years afterwards, in 1533, Pope Clement died,† when the works then proceeding at the library and sacristy in Florence, which, notwithstanding all the efforts made, were not yet finished, were at once laid aside. Towards the middle of 1555, during the time of Paul III, "Duke Cosinio had sent Tribolo to Rome, to try if he could persuade Michaelagnolo to return to Florence, there to finish the sacristy of San Lorenzo; but the master had excused himself, saying, that he was become old, might no longer endure the fatigue of labor, and could not leave Rome. Tribolo then enquired as to the steps for the library of San Lorenzo, for which Michaelagnolo had caused many of the stones to be prepared, but for which no model nor any certain indication of the form in which they were to be constructed, could be found. It is true, that there were some few sketches of a pavement and other things in terra, yet the correct and final design of the work could not be ascertained. But not all the entreaties of Tribolo, although he brought in the name of the Duke, could move Michelagnolo to say more than that he did not remember. The Duke then commanded Vasari to write to the master, since it was hoped that for the love of him, Michelagnolo would perhaps say something, which might enable them to bring the work to conclusion. Vasari wrote to him accordingly as the Duke desired, adding, that of all which had to be done Vasari was to be the director, and would do everything with the utmost fidelity, taking care of every minutia, as of a work of his own. To this Michelagnolo replied by sending the plans for the work in a letter, written by his own hand, on the 28th Sep^r. 1555. 'Messer Giorgio, my dear friend—About the staircase, whereof there has been so much said, believe me, that if I could remember how I had arranged it, I should not require so many entreaties. There is a certain stair, that comes into my thoughts like a dream; but I do not think it is exactly the one which I had planned at that time, seeing that it appears to be but a clumsy affair; I will describe it for you nevertheless. I took a number of oval boxes, each about one palm deep, but not of equal length and breadth. The first and largest I placed on the pavement at such distance from the wall of the door, as seemed to be required by the greater or lesser degree of steepness you may wish to give to the stair. Over this was placed another, smaller in all directions, and leaving sufficient room on that beneath for the foot to rest on in ascending; thus diminishing each step as it gradually retires towards the door; the uppermost step being exactly of the width required for the door itself. This part of the oval steps must have two wings, one right, the other left. The steps of the wings to rise by similar degrees, but not to be oval in form. The ascent by the middle flight, from the centre to the upper part, shall be for the Signore; the turn of the wings must be towards the wall. But from the centre downwards to the pavement, they shall be kept at the distance of about three palms, in such sort that the basement of the vestibule shall not be infringed upon in any part. What I am writing is a thing to be laughed at, but I know well that you will find something suitable to your purpose.'‡

In a brief conversation on the subject, which I had with Monsieur Benvignat, the architect of Lille, he gave it as his opinion, that the sketch exhibited in the Wicar collection is the original idea of Michael Angelo; that he had lost the book, and forgotten this his first conception. But the sketch is equally at variance with the master's letter just quoted, and the staircase as executed. The sketch presents an oval series of steps,

* Vasari's Lives, translated by Mrs. Foster, vol. v. p. 272.

† Page 282.

‡ Gaye in his Carteggio, makes it doubtful whether Vasari finished these steps or not; and a Florentine commentator says, "Although Michael Angelo had left the steps, the balustrade, and many other parts of this work in a state of preparation, it is manifest that Vasari did not succeed in comprehending the master's wish. He constructed a magnificent flight of steps, without doubt, but not that intended by Michael Angelo."—See *Ruggieri, Studio d'Architettura Civile*; also *Rossi, Libreria Medicea Laurenziana*.

half without and half within the door of the library; but the number would not have accomplished half the height to which it was necessary to rise, and although oval like the boxes alluded to by Michael Angelo, there are no side steps.

So restricted is the vestibule, that the intrusion upon the space of the floor, by the capricious form given to the flight as executed, leaves very inadequate room for the landing at the bottom of the stairs; and if any method could have been devised of gaining space by making some of the steps rise within the doorway, much convenience would have been gained. I am inclined therefore to think that this sketch is a slight idea of Vasari's, founded upon some vague rumour of Michael Angelo's arrangement, to try how it could be carried into execution, before he had received the master's formal instructions.

This brings us to the consideration of the important question, who was the real author of these sketches? My own impression is, that *the whole book* may be attributed to Vasari himself—that all the sketches of the Library, of the Cupolino of the Sepulchral Chapel, and of the other details of Michael Angelo's work, were taken for his own guidance, or for the purpose of sending off copies to the Master, to enable him to give the proper instructions to direct Vasari's proceedings in the completion of the buildings confided to his care.

The sketches generally are executed with a certain ready freedom of hand and no great care; but some are drawn with much delicacy and with considerable precision and minuteness of form. Hardly more than two or three evince that bold and vigorous freedom of treatment, which we are accustomed to consider as characteristic of the Maestro, as Vasari repeatedly calls him. One circumstance particularly struck me, and that was the numerous sketches of the circular chapel built in the cloister court of S. Pietro a Montorio, by Bramante. This building excited vast admiration at the time, and Serlio himself gives the plans, elevations and sections of it in his work next to those of the cupola of S. Peter's, and among the numerous illustrations of ancient buildings, and Palladio also gives it among his ancient edifices. Other writers of the time mention it with unqualified praise. It would therefore be no wonder if a Vasari, who was employed upon designs and models for tombs at S. Pietro a Montorio by order of Julius III., should have sketched parts and kept a record of such details. But that Michael Angelo, who despised the trammels of *ancient art*, should condescend to the task of minutely drawing the work of a cotemporary, and that cotemporary no friend of his, but the uncle and supporter of his rival Raphael, and one, who crossed him in his great work for the tomb of Julius, seems beyond probability, however noble were many impulses of Michael Angelo's generous nature. I am given to understand, that many French artists, who have visited the Wicar collection, concur in my opinion as to the propriety of not attributing this collection of sketches to Michael Angelo; and a distinguished member of the French Institute, a great amateur and connoisseur, assures my friend Hittorff, that he had traced the writing on some of these drawings, and that it did not at all accord with that of the great master. I am therefore confirmed in the conviction, that these architectural sketches are not the production of Michael Angelo.

I shall now notice a letter from Francois I. to Michael Angelo; but before I put you in possession of this most precious of the treasures of the Wicart collection, it is necessary for me to give a few particulars of one, to whom it refers, and which I shall do by quoting another passage or two from Vasari. Francesco Primaticcio was sent by the Duke Frederigo of Mantua to France, at the request of Francis I., who, having heard of the decorations, with which he was adorning the Palazzo del T, desired to have an able artist to execute like works for him at Fontainebleau, and elsewhere. Primaticcio, according to Vasari, was the first to paint frescoes of any account for the French king, and we all know how admirably he succeeded in the great and superb ball room at Fontainebleau.

"King Francis, being much pleased with the conduct and proceedings of Primaticcio, sent him in 1540 to Rome, he having put the wish, according to Benvenuto Cellini,† into that monarch's head to possess antiques. He purchased several antiques in marble, and served the king so diligently, that what with

* Vasari's Lives, translated by Mrs. Foster, vol. v. p. 371.

† Vita, vol. ii. p. 131, Ediz. di Milano, 1811, 8vo.

heads, trunks, and entire figures, he bought in no long time 125 pieces. At the same time Primaticcio caused Barozzi da Vignola and others to copy the bronze horse of the Capitol, the greater part of the reliefs of the column, (probably Trajan's,) the statue of Commodus, the Venus, Laocöon, the Tiber, the Nile, and the statue of Cleopatra, which are in the Belvedere, and all which were to be cast in bronze."

" Being recalled to Paris he returned immediately. But, before attending to any other occupation, Primaticcio caused the greater part of those antiques to be cast, when all succeeded so well, that they might be taken for veritable works of antiquity, as may still be seen " says Vasari " in the Queen's garden at Fontainebleau, where they were placed to the great satisfaction of King Francis, who may be said to have there made another Rome."

" The king, perceiving that he had been well served during the eight years, that Primaticcio had been with him, appointed the painter to be one of his Chamberlains. And shortly after (in 1544 that is to say) his Majesty made him Abbot of S. Martin (at Troyes.) "

The document, which rendered necessary these preliminary remarks, is as follows:

S^r Michelangelo pourceque jay grant desir d'avoir quelques besognes de v^{re} ouvrage jay donne charge a labbe de Saint Martin de Troyes p^{nt} porteur que j'en voye pardela den recouvrir vous priant si vous avez quelques choses excellentes faictes a son arrivee les luy voulloir bailler en les vous bien payant ainsi que je luy ay donne charge Et davantaige voulloir estre contant pour lamour de moy quil molle le christ de la Minerve † et la n^{re} dame de la febre ‡ affin que jen puisse aorner lune de mes chappelles comme de chose que lon ma assure estre des plus exquises et excellentes en v^{re} art. Priant dieu S^r Michelango (sic) quil vous ayt en sagarde. Escript a Saint germain en Laye le VIII^e jour de feurier m^vxliv.

FRANCOYS.

No. 199.

DELAUBESPINE.

This letter proves that Primaticcio must have made a second visit to Italy for the purpose of collecting more works of art, and its truly princely sentiments evince the taste, the liberality, and high-minded generosity of a real lover of the fine arts. How fortunate has France been for three centuries in having princes who felt, that the fine arts can contribute essentially to the refinement, the happiness, and prosperity of a nation. This spirit has endowed Fontainebleau, Paris, and Versailles with the masterly productions of the greatest minds in Italy and France. The lower orders have their enjoyments in common with the princes, the nobles, and gentry of the land; and they grow up imbued with the love of that art, which is so mixed up with their holiday enjoyments, that it becomes a necessity, as it were, from their being used to it from their earliest years; and they are thus unconsciously educated by the contemplation of the finest works. How far are we in this respect behind our neighbours. The gardens of the Tuilleries have no parallel with our royal residence of Buckingham Palace; and Fontainebleau puts to shame the courts, and terraces, and gardens, and walks of Windsor Castle, which contain hardly a single statue, group, or fountain, or other art accessories of any consequence, and appear cold and meagre, and poverty stricken from the want of such accompaniments. So niggardly and deficient in art feeling have those authorities been, who have hitherto had to provide for the palaces of our Sovereigns, and the places of public resort for the people. Often was Francois I. thwarted by his ministers in his munificent desire to promote the fine arts, but he was not to be turned away from an object, which he knew would gratify his people and ennoble his country. And well has this noble spirit been rewarded for his early enlightened cultivation of the fine arts, for his example

* This celebrated statue is still preserved in the Church of the Minerva, near the Pantheon, Rome.

† This statue was, according to Vasari, executed for the Cardinale di S. Dionigi, to put in old S. Peter's, in the Chapel of the Virgin Mary of the Fever. I have made ineffectual enquiries to ascertain precisely where this statue is. Mons. Hittorff thinks it the Madonna della Pietà, the cast of which was in one of the chapels of Fontainebleau up to the time of the Revolution. Probably it may be the Pietà of S. Peter's, at Rome, re-named after the time of Vasari.

has been followed by the continued munificence of succeeding monarchs and ministers, which has produced that superiority in the art productions of their manufactures, which enables them to compete so successfully with the mere mechanical skill and industry of other nations.

Michael Angelo has been the main topic, to which I have been so bold as to claim your attention; and surely his position as an artist claims for him the respect and admiration of every painter, sculptor and architect. And although he was a great innovator in architecture, and introduced a license, which was most pernicious to the art, yet we cannot but recollect that we owe to him the simplicity of design, to which he reduced the cupola and other decorations of S. Peter's, which had been sadly corrupted by the immediate successors of Bramante, whose original conception had been lost. Vasari mentions* that "while Antonio San Gallo lived, Pope Paul had permitted him to continue the building of the Farnese Palace. But the upper cornice on the outside was still wanting; and his Holiness now desired, that this should be added by Michael Angelo, after his own design and under his direction. The master, therefore, not willing to disoblige the Pope, who esteemed and favored him so much, made a model in wood, seven braccia long ($13\frac{1}{2}$ ft.), and of the exact size which the cornice was to be. This he caused to be fixed on one of the angles of the palace, that the effect might be seen, when, as the Pontiff and all Rome with him were much pleased therewith, it was put in execution, proving to be the most beautiful and varied cornice ever erected, either by the ancients or moderns.† He continued the great court also, constructing two ranges of columns over those first erected, with the most beautiful windows, and a great variety of rich ornaments, ending with the great cornice; all of these works being so beautiful, that this Court by the labor of Michael Angelo has now become the finest of all Europe."

You will doubtless remember the beautiful picture by Haghe in the New Water Color Exhibition of the year 1848,‡ representing Michael Angelo, himself an old man, nursing by his midnight lamp his faithful servant Urbino, who was ill; his master sleeping at night in his clothes beside him, the better to watch for his comforts. Vasari gives the following touching letter written to him by Michael Angelo on this occasion: "My dear Messer Giorgio—I can but ill write at this time, yet to reply to your letter I will try to say something. You know that Urbino is dead, and herein have I received a great mercy from God, but to my heavy grief and infinite loss. The mercy is this, that whereas in his life he has kept me living, so in his death he hath taught me to die, not only without regret, but with the desire to depart. I have had him twenty-six years, have ever found him singularly faithful, and now, that I have made him rich, and hoped to have in him the staff and support of my old age, he has disappeared from my sight, nor have I now left any other hope, than that of rejoining him in paradise. But of this God has given me a foretaste, in the most blessed death that he has died: his own departure did not grieve him (so much) as did the leaving me in this treacherous world with so many troubles. Truly is the best part of my being now gone with him, nor is anything now left me, except an infinite sorrow. And herewith I bid you farewell."

I have been insensibly led, by the interest, which attaches to the talents and character of this great man, to depart from the immediate subject of my paper, and to conclude my remarks by an allusion to his works at the Farnese, and by the contemplation for a moment of the affecting incident, which lays open the inmost soul of Michael Angelo, and shews him with the tenderest regard as a kind master, and the finest feelings of the most pious resignation in the contemplation of his own not far distant end,—as exemplary as a Christian, as he had been eminent and admirable as an artist. But I will now conclude, and trust,

* Vasari's Lives, translated by Mrs. Foster, vol. v. pp. 296-7.

† The cornice to the Strozzi Palace at Florence, must have suggested to Michael Angelo the grandiose character of that of the Farnese of Rome.

‡ See Illustrated London News, 22nd July 1848.

that I may not be considered too presumptuous in so boldly offering my opinion as to the authorship of these architectural sketches. Whosoever they may be, whether Michael Angelo's, or Vasari's, or any other artist's, they are extremely curious and interesting in the history of our art. I hope that none of my professional brethren, who have not yet seen these drawings, will now pass through Lille without visiting this fine collection. They will then, in addition to the delight they will experience in seeing the masterly thought-renderings of other great men, be enabled to judge for themselves and to decide; whether I am wrong or right in hesitating to attribute to the mighty Florentine these architectural sketches, which well deserve the minutest attention from every lover of architecture.

THE PRESIDENT, EARL DE GREY, called upon the Meeting to award their thanks to Mr. Donaldson, for his interesting and valuable paper, which he was confident they would do unanimously.

Mr. TITE, Fellow, stated it had happened to him, in the summer of last year, to be detained in Lille for five hours on a wet afternoon, waiting for the train to Calais, when he was directed to the Musée, in order to pass a portion of that time. Proceeding to the rather magnificent Hotel de Ville described by Mr. Donaldson, of which he had never heard before, he was astonished to find, not only the marvellous collection of drawings referred to, but an extensive and interesting museum, illustrative of art, antiquity and ethnology. So easily might Lille be visited, and so well did the collection deserve further inquiry, that he strongly recommended his hearers to go there. In reference to the architectural portion of the drawings, he was sorry to find that Mr. Donaldson considered they were not, as he (Mr. Tite) had fondly hoped, the work of Michael Angelo. Mr. Donaldson had brought forward strong reasons in support of his opinion; and to his judgment and knowledge of the subject, he must at once defer. He had himself copied from one of the drawings the name of Michael Angelo, which was clearly written upon it; and it would be very easy to compare that with his undoubted autograph, so as to settle the question. One of the largest of the drawings appeared to him to be the first sketch of the great architect for the dome of St. Peter's, with the double cupola. He was informed at Lille that M. Wicar was employed by Napoleon Buonaparte in Italy, to collect works of art, and that in doing so he helped himself to these drawings, which he bequeathed on his decease to his native city. In addition to the interesting letter of Francis I. which Mr. Donaldson had read, he begged to read the following, from Buonaparte to M. Wicar, which was exhibited with the drawings; and which, notwithstanding certain peculiarities of diction, he had no doubt was dictated by Buonaparte himself, in 1796, from Milan.

Armée d'Italie.

Republique Française.

Liberté, Egalité.

Au Quartier General.

Milan le 22 Prarial.

Au 4^e de la Republique—une et indivisible.

Bonaparte General en Chef de l'Armée d'Italie.

Au M. Wicart, peintre à Florence.

J'ai reçu votre lettre du 9 Prarial. Je n'y ai point reçu les esquisses que vous m'avez annoncées.

Je vous engage à continuer d'occuper votre talent d'objets dignes de l'homme qui pense.

Je serai toujours fort aise de pouvoir de vous être bon à quelque chose.

BONAPARTE.

The sketches generally were singularly curious and beautiful; and he had been so much struck with them that he had contemplated interesting the architects of France, with a view to have them published in lithography; which might be easily and cheaply done; and he would suggest to the Council that they might

be able to promote this object. Whoever was the author of the sketches, he thought they might prove very useful in restoring the magnificence of ancient Rome. With regard to the Basilica of Constantine, he should be very glad to believe that there had been such a portico as the drawing referred to by Mr. Donaldson indicated. He believed, however, that both Palladio and Canina (the latter especially) were quite inclined to include a portico in their restorations of that building; but that it would be found that there could not have been such a portico, unless indeed the Via Sacra could be supposed to have passed within it. The Institute were under the greatest obligation to Mr. Donaldson for the attention he had given to the illustration of these works,—which were undoubtedly the production of some very clever man, if not of the great maestro himself.

Mr. DONALDSON stated that he had intimated to M. Benvignat, who was a member of the Commission, having the care of these drawings, that he was sure the Institute would be much pleased to have tracings of them; but that gentleman believed this would not be possible, inasmuch as the Commission had the intention of publishing them very shortly. It would, however, be desirable to express the interest which this Institute felt in the matter, with a view of promoting that result.

Mr. BELL, M.P. Fellow, bore testimony to the extreme value and interest of the drawings, both in an architectural and artistic point of view. He had himself intended to revisit them, and prepared a paper on the subject; but he rejoiced that, in directing Mr. Donaldson's attention to them, he had ensured its being much more ably done.

The vote of thanks to Mr. Donaldson was then carried.

Some specimens of serpentine from the Lizard, Cornwall, were exhibited by Messrs. Brace and Colt. These specimens excited general admiration from their large size, high polish, and extreme beauty of colour,—and it was stated that the defects arising from the brittleness of the material, and its liability to decay, were almost entirely obviated when the stone was raised from some depth below the surface; in which case it was also procured in much larger slabs. Mr. Tite and Mr. Donaldson insisted upon the above defects in this otherwise beautiful material, as hitherto worked; but a hope was expressed that, with improved mechanical appliances, much better specimens might in future be brought into the market.

In answer to these observations, Mr. Brace gave a short explanation of the operations at the quarries referred to. He stated that he and Mr. Colt were the first persons who had ventured to open quarries of any considerable depth; that the experiment had been highly successful, stone having been obtained vastly superior both in colour and working qualities to any that had hitherto been produced; that there was every prospect of blocks of large size being readily obtained, of great variety in colour and general appearance; that the specimens shewn would compete in point of price with marbles of very inferior quality; and that there was no doubt that the objections that had been raised to stone obtained from the surface and the beach, portions of which had recently been used, would be entirely overcome, as stone of sound quality was readily obtainable from the lower depths of their quarries. Mr. Brace read an extract from the Geological Observer of Sir Henry de la Beche, in reference to the composition of the stone, to the following effect:

Taking the composition of serpentine and of olivine from the thirteen analyses, of each by several chemists, such as are given by Professor Nicoll in his Manual of Mineralogy, the similarity or difference would be as follows—

	Serpentine.	Olivine.
Silica	41 . 99	41 . 92
Magnesia	40 . 24	46 . 67
Oxide of Iron	3 . 38	10 . 75
Water	12 . 68	

The Meeting was then adjourned to the 28th of November.

ON THE APPLICATION OF PAINTED GLASS TO BUILDINGS IN VARIOUS STYLES OF ARCHITECTURE.

Read at the Ordinary General Meeting of the Royal Institute of British Architects, November 28th, 1853.

By C. WINSTON, Honorary Member.

IN composing this paper on Painted Glass with reference to its employment in Buildings in various styles of Architecture, I have endeavoured as much as possible to keep in mind the practical objects of this Society. Many matters, therefore, of interest to the antiquary, will be passed unnoticed, or with a brief allusion to them—my object being, as far as I am able, to supply an answer to the question, What is the kind of painted glass best suited to a building of a given character?

On a question so wide and complicated, it is not only natural that very different opinions should exist, but extremely difficult to ascertain which is the most correct. The inadequacy of language to express ideas so subtle as those of which questions of taste are composed, must ever be an insuperable obstacle to bringing questions of taste to a certain determination by argument: a consideration which is condemnatory of the modern vice of dogmatizing upon such subjects. And the nature of the only remaining tribunal—the concurrent opinion of men of taste—that is of men who have given their attention to such matters, and whose views are respected by others engaged in the same pursuits—of itself sanctions a great latitude of sentiment. The feelings and habits, the education and temperament of individuals, even their natural appreciation of form or colour, all insensibly influencing their opinions on a subject respecting which there exists no definite standard. I am therefore very far from claiming any sort of infallibility for the views I am about to submit to your consideration—views which I shall attempt to support rather by calling your attention to objects with which you are already familiar, than by elaborate argument.

The variety of buildings which may require to be decorated with painted glass is great. Some are in the Greek, or Palladian styles of architecture, others are in the Gothic styles; and each building may be more or less grave or solemn in its aspect than others of its class. Such differences in the buildings demand, of course, corresponding differences in their painted windows. But before entering upon this topic, it will be convenient to declare what I believe to be the best subjects for glass painting, and the best mode of executing them. With regard to the mode of executing glass paintings, I will recall your attention to a paper which I read here, about a year ago, on the *Methods of Painting upon Glass*.* In which, after stating that there were three distinct modes of executing glass paintings, viz. by the mosaic method, in which the local colouring of the picture is produced by means of glass coloured in its manufacture, the shadows and outlines only being executed with an enamel colour; by the enamel method, in which the colouring of the design is effected by using enamel colours; and by the mosaic enamel method, by which the colouring of the picture is produced by a combination of the two former methods,—I concluded that the mosaic method was the best; because it was, from the nature of the thing, more favourable than either of the others to a display of the translucent quality of glass, and consequently of its brilliant and powerful colours—whilst, at the same time, it afforded the means of executing works as highly pictorial as the windows of the transepts and north chapel of Brussels Cathedral—works which maintain their superiority in point of effect, when compared with a series of later examples, including some of the most beautiful specimens that modern continental art can boast. This conclusion—for the soundness of which I must refer you to the paper I have named, and to the works of art therein mentioned—will confine our inquiry to what are the subjects best adapted for representation in glass paintings, executed according to the mosaic method.

* "*On the Methods of Painting upon glass*," read at the Ordinary General Meeting of the Institute, 7th March, 1853, and published in the *Transactions*.

These subjects may be divided into the following classes:—Patterns, similar to those used throughout the Mediæval period, and which usually consist of ornamental work in white glass, but sometimes of scrolls of foliage, either white or coloured, on a coloured ground. Pictures, where the objects are represented as seen in one plane, as in a bas-relief—such as we see in the painted windows of the 12th and 13th centuries; and pictures, where the objects are represented as occupying several planes, as in nature—such as we meet with in the painted windows of the first half of the 16th century; and, of course, compositions consisting entirely of such patterns or pictures, or partly of patterns and partly of pictures. To avoid any possible misconception, I should perhaps here state, that any reference to Mediæval examples in this paper is made only for the purpose of illustration, and not with any intention of conveying an impression that they are fit objects of imitation. Most valuable hints are doubtless to be obtained from an enlightened examination of such examples; but before we think of copying them, we ought to be quite sure that they are worth copying; and I will undertake to say that not one ancient example of painted glass, except, perhaps, those consisting of pattern work, can be considered as a perfect model for imitation. All, with the trifling exceptions I have named, of whatever date, are defective in one way or another, either in composition, drawing, or general effect. Even the finest cinque cento examples, which, taken collectively, are perhaps of all ancient examples the least open to criticism, were done at a time when the human figure was but imperfectly understood by the glass painters. And with regard to the often expressed notion, that it is better to submit to copies of mediæval examples than trust to modern invention, permit me to say that a more unjust imputation against the taste and skill of the 19th century never was made, or a more complete apology conceived for indolence and incapacity. Whose fault is it, I would ask, that low art, at least in regard to glass painting, should seem to be almost inseparably associated with what are called Church principles of architecture? Are not the patrons of the art to blame for indolently acquiescing in and sanctioning a mere system of copying, because they have not sufficient energy to study glass painting thoroughly, and make themselves acquainted with its principles? We may depend on it, if glass painting, or I may say art in general, had a practical bearing on the affairs of life, instead of only furnishing a means of amusement, we should no more hear of currency being given to such doctrines respecting it, than we now hear engineers advocating our going back to the single-condensing steam engine, or travellers by railway yearning for a return to the old horse tracks.

The patterns to which I have alluded, do obviously comply with the conditions of the mosaic method in the fullest and simplest manner; for the brilliancy of the glass is altogether unsubdued in these works, and the mechanical construction of the window is in harmony with their design—the leadwork connecting the pieces of glass, either forming an integral part of the pattern, or else actually constituting the pattern itself. I may illustrate my meaning by a reference to familiar examples, such as the Five Sisters, at York, and the geometrical pattern works, executed in white glass, so common in the 17th century, particularly on the Continent, of which engravings have occasionally appeared in the “Builder.”

Turning from these, the works which next appear the most completely and simply to comply with the conditions of the mosaic method, are the pictures of the 12th and 13th centuries; for, of all pictures, these admit of the employment of glass of the most powerful hue, and the least diminish its brilliancy. Here also, the leadwork is made conducive to the effect of the design. It is true that in the cinque cento style we meet with pictures in which, as in a bas-relief, all objects are represented as occupying one plane as effectively as in a picture of the earlier period; but in no glass paintings is the bas-relief principle of representation effectively carried out with so much *simplicity* as in the pictures of the 12th and 13th centuries. This, I apprehend, is owing no less to the nature of the glass of which these works are formed, than to the composition of the picture. This glass, when compared with the glass used in later times, is remarkable for its apparent solidity—a quality which, without sensibly detracting from the brilliancy of the glass,

imparts great depth and richness to its hues. Hence the artists of that early period were able to leave large breadths of glass in their pictures unincumbered with any enamel colour—with which, in the mosaic style, as I have already informed you, the painting of the picture is performed—without incurring the risk of producing a weak or flimsy effect. We all are aware of the fact, that the shields of arms and the panel grounds, which in later years were so profusely adorned with diaper patterns, executed with the enamel brown paint, are in the works of this period usually left quite plain—the artists appearing to rely for effect on the tone and richness of the material itself. So we perceive, on examining a figure in any one of these early pictures, that whilst the deepest shadows are represented in the simplest manner by opaque lines, and the shadows in half-tint by a slight wash of enamel brown, the proportion of the glass left quite clear for the high lights, is much larger than in later glass paintings. That such a simple mode of execution, if applied to a more pellucid and watery material, must necessarily produce only a poor and flimsy effect, may be learnt from the modern copies of 13th century glass. But without dwelling on this point, I will call your attention to the composition of a 12th or 13th century picture, as of itself ensuring distinctness without the aid of any great breadth of shadow. This is simple enough: it consists in arranging the figures in one line, usually on a bar crossing the picture; in keeping the action of the figures as much as possible in the direction of the plane of the picture, and in insulating and separating the figures by the ground of the picture—a treatment, as you perceive, corresponding with that of an antique bas-relief. And since this treatment is in general more intelligibly carried out in the earlier examples, I think we may venture to ascribe it to the fuller influence of classical art at an early period of glass painting. In addition to this, as a general rule, the colouring of the figures is kept lighter than that of the ground of the panel. Of course these remarks are derived from an examination of a great many examples. I mention this, because I could easily contradict almost every one of them by a reference to particular works. It is from a majority of specimens only that a general principle is to be collected. The subjects to which I have just alluded are necessarily characterized by a certain archaic formality, arising from the stiffness of the colouring, and the simplicity of the design and execution. I have now to direct your attention to subjects of another class, as remarkable for their pictorial effect. I mean the picture glass paintings of the first half, or more correctly, of the second quarter of the 16th century. These works are in many respects the very opposites to those just described. Their colouring is harmonious rather than deep, and they are highly finished—peculiarities which I could shew to be connected with the nature of the glass employed in these works, which, without being as flimsy and pellucid as ordinary modern glass, is yet very inferior in depth and richness to that of the 12th and 13th centuries. Still these works will be found to comply with the conditions of the mosaic method, after making allowance for their different nature, equally with the works of the 12th and 13th centuries; and I hope I shall be able to prove that they are entitled to equal estimation. Their composition is various, consisting sometimes, as in the pictures of the 12th and 13th centuries, only of a line of figures occupying a single plane; but more commonly of a group—of *foreground* figures, it is true, but which in parts recedes from the eye: the figures not unfrequently occupying in plan, the arc of a semi-circle, as in some of Raphael's designs; and beyond the figures some distant object is usually represented, such as the sky, or a landscape. The picture, therefore, is designed on the principle of representing depth, and, in the best examples, is executed in such a manner as to produce the effect of depth. The means resorted to for this purpose are very simple. First may be noticed, the choice of such subjects as are capable, without a violation of probability, of being represented in a somewhat severe, if not harsh manner: thus a landscape, or a sea piece, a full idea of which cannot be conveyed without representing the graduated tints and soft outlines of nature, was never, at this period, selected as the *principal* subject of a glass painting. On the contrary, when a landscape background is adopted, it is used merely as an accessory, to set off and relieve a group of

foreground figures, in which all the interest of the composition centres. And, secondly, we may remark, that all the objects in the picture are represented as if they were seen under the influence of broad sunshine—a mode of treatment the most favourable, not only to a display of bright lights and sharp decided shadows, but to the general transparency of the picture, it being possible by this means to separate the various objects from each other, without having recourse to extensive masses of shadow or concentration of light, the use of which, however effective in the works of Rembrandt and other oil painters, is wholly unsuited to the conditions of glass painting, on account of its very limited scale of transparent shade. The heaviness resulting from the adoption of the opposite principle, of concentrating the light in the middle of the picture and keeping the rest in comparative obscurity, is shewn in the upper subject of the west window of New College Chapel, Oxford, and in the west window of Magdalen College Chapel, and in a variety of modern works; and the superiority of the sunshine principle becomes apparent on comparing these works with others in which it is adopted, as the windows of the North Chapel of Brussels Cathedral, those of St. Jacques Church, Liege, or the windows of Lichfield Cathedral.

A glance at the drawings on the wall, of portions of the glass at Brussels and Lichfield will explain my meaning better than any words I can employ. We there see, that the figures are cut out from the background, and the architecture from the sky or landscape; as much by the opposition of light and shade, as by the local colours: and thus the crispness and clearness of a sunshine effect is not only highly conducive to the brilliancy of the window, but is most favourable to the concealment of the leads, which form part of and are wholly lost in the sharply defined shadows with which the foreground objects are bounded, and even in the background are on a close view not unfrequently absorbed in the colouring, but at all events pass unobserved in the general crispness of the picture, when it is viewed from the proper distance. Of course I am not speaking of the broad modern lead, used in repairs of old glass, but of the ancient leads themselves, which never until almost the beginning of the 17th century exceeded $\frac{3}{16}$ of an inch in width. In cinque cento glass paintings therefore, the leadwork forms an integral part of the design, equally as in a 12th or 13th century picture. And these works also evince a thorough compliance with the mosaic system in preserving the translucent qualities of glass. A cinque cento glass picture, notwithstanding the power of its shadows and high finish, which entirely save it from the charge of weakness or poverty, is still a brilliant and diaphanous glass picture; owing, partly to the crisp treatment alluded to, partly to the care taken to leave considerable portions of the glass, though not such relatively large portions as may be seen in the works of the 12th and 13th centuries, unencumbered with enamel brown. But without going further into the minutiae of the subject, I will ask any one accustomed to compare glass paintings of different dates, whether in any so high a pictorial effect has been produced with so little diminution of brilliancy, as in the works of the 2nd quarter of the 16th century.

You will perceive that from this summary I have omitted all notice of glass paintings of the 14th and 15th centuries. I have done so from a conviction that the nearest approach to an artistically flat style of representation is to be found in the works of the 12th and 13th centuries; and that the nearest approach to an artistically rotund style of representation is to be found in the works of the second quarter of the 16th century: and that there is nothing to choose between a really flat and a really rotund style. At first sight there is, I admit, but little difference between a 13th century and a 14th century picture, in point of composition; but a closer examination generally brings to light various minute differences, tending to shew, either that the artists of the 14th century were already contemplating a change from flatness to rotundity of representation, or that they did not strictly adhere to their predecessors' rules for ensuring distinctness in a flat style. The inconsistency, not unfrequently seen in works of the 13th century, of representing the figure in relief, but omitting to indicate the recess of the niche in which the figure is supposed to stand—a mistake which perhaps arose from imitating in glass too literally the designs of

ancient goldsmiths' work, where, as every body knows, embossed figures are often stuck on a flat ground, having architectural forms drawn in outline upon it—is repeated and exaggerated in pictures of the 14th century. Indeed, most of the 14th century groups that, according to the usual fashion of the day, are surmounted with shrine work, look just like groups painted on flat panels, fringed by way of ornament with spires and crockets; so completely does the apparent flatness of the canopy—rendered no doubt more conspicuous by the increased elaboration of its details—correspond with the flatness of an ordinary panel. And the figures themselves, owing partly to the increased breadth of their draperies, inattention to the principle of insulating them by means of the ground colour of the panel, and a bad selection of the colours of the drapery, certainly do not in general appear at a distance so distinct as the figures in a 13th century picture. I therefore cannot but regard the 14th century style of glass painting as inferior to the 13th, and the 15th century style as inferior to that of the 14th. The 15th century was evidently passed in the effort to get out of a flat style of representation into a rotund one. It is true that all the pictures of this period appear to be flat, but they are flat in effect only, and not on principle; their flatness is the result of imbecility, not of design. They are designed as much on the principle of depth as a cinque cento glass painting, but they do not, like it, produce the effect of depth, because their designers were ignorant of the means of attaining the desired result. As in a cinque cento glass painting, so in one of the 15th century, the figures are not unfrequently arranged on the arc of a semi-circle, and are not cut out or separated from each other by stiff colour. And that the intention was to represent depth is plain from the representation of distant objects, of sky and landscape, coloured with considerable regard to the hues of nature; but, contrary to the practice of the cinque cento artists, the shadows are sometimes misplaced, and are always too weak; and the gradations of colouring, though such gradations might have been as easily made as in cinque cento work—the nature of the material being the same in both cases—are not sufficiently attended to. Hence the glass pictures of the 15th century, beautiful as they sometimes are in detail, remind one in general of an assemblage of court cards. They frequently produce no other effect, even at a moderate distance, than that of a mosaic composed of strangely-shaped pieces of glass of various colours. I think, therefore, that we may leave the works of the 14th and 15th centuries as objects chiefly interesting to the antiquary.

Having thus indicated, as briefly as I could, the sort of subjects which appear to be most suited for glass paintings, I will endeavour to shew what sort of glass paintings are best suited for particular buildings. And here the real difficulty of the subject may be said to commence; for since no example of contemporary glazing is to be found in any building earlier than the middle ages, it is only by analogy that we can arrive at the fitness of painted glass for classical buildings, if we rely on experience as a guide; and in a matter of this sort, I fear there is no guide so trustworthy as experience. It will be admitted, I apprehend, that the earlier Gothic styles are more severe in their architectural character than the later ones; and I think that you will likewise admit, on reflection, that the glass most in harmony with Gothic buildings in the Norman or early English styles, is that of the 12th and 13th centuries. I have tried for a long time past to discover the reason of this conformity, and have arrived at the conclusion that the harmony between the painted windows and the architecture depends far more on the colouring of the windows than on their design. I have often contemplated the general effect of 13th century, of 15th century, and even of 16th century painted glass, in the windows of a Norman or Early English building, from a distance too great for admitting of my making out the design with any degree of distinctness, and have invariably observed that the colouring of the earlier glass most accorded with the character of the architecture, and that the harmony was the same, whether the windows were almost entirely formed of white glass, like the Five Sisters at York, or were richly coloured, as at Bourges or Canterbury. As might have been expected, I have not met with the same opportunities of contrasting the effect of 13th century painted glass with that of the

15th or 16th century, in reference to its harmony with the architecture of the 16th century, but such experiments as I have been able to make have tended to create an impression on my mind, that the glass paintings of the 15th and 16th centuries do harmonize more completely with the character of the architecture of the 15th century than the glass paintings of the 13th. However, without pressing the last point, I will venture to express a firm belief that the colouring of a 16th century glass painting does harmonize better with the character of a building in the Renaissance style, than that of a 13th century glass painting.

In these conclusions I would beg you to observe that I have been influenced by the general effect of the glass painting, rather than by its force, because I have remarked that good cinque cento glass paintings, which are hardly if at all inferior in power to Early English ones, do not in general harmonize with 13th century buildings so completely as the windows of the 13th century. The inference I draw from these experiments is, that there is an analogy between the colouring of 12th and 13th century windows, and buildings remarkable for the gravity and solemnity of their appearance. And this, when the nature of the colouring of these windows is analysed, will I think be found to accord with Sir Joshua Reynolds' views. He says in his 4th discourse, "with respect to colouring, though it may appear at first a part of painting merely mechanical, yet it still has its rules, and those grounded on that presiding principle, which regulates both the great and the little in the study of the painter. By this the first effect of the picture is produced, and as this is performed, the spectator, as he walks the gallery, will stop or pass along. To give a general air of grandeur at first view, all trifling or artful play of little lights, or an attention to a variety of tints, is to be avoided. A quietness and simplicity must reign over the whole work, to which a breadth of uniform and simple colour will very much contribute. Grandeur of effect is produced by two different ways, which seem entirely opposed to each other. One is by reducing the colours to little more than chiaro-oscuro, which was the practice of the Bolognian schools, and the other by making the colours very distinct and forcible, such as we see in those of Rome and Florence. But still the presiding principle of both those manners is simplicity. Certainly nothing can be more simple than monotony: and the distinct blue, red, and yellow colours, which we see in the draperies of the Roman and Florentine schools, though they have not that kind of harmony which is produced by a variety of broken and transparent colours, have that effect of grandeur which was intended. Perhaps these distinct colours strike the mind more forcibly, from there not being any great union between them; as martial music, which is intended to rouse the nobler passions, has its effect from the sudden and strongly marked transitions from one note to another, which that style of music requires; whilst in that which is intended to move the softer passions, the notes imperceptibly melt into one another." Now if we compare the colouring of a 13th century glass painting with that of a cinque cento one, we perceive that the colouring of the former consists of an assemblage of powerful, distinct, positive tints, skilfully arranged, but more on the simple principle of a mosaic, than on the more blended principle of a painting. Whilst the tints of the latter are less forcible, less decided, and more blended together. I have seen some cinque cento glass pictures in which there is no red, and but little positive blue, the colouring being almost entirely composed of secondary tints, and in which the transition from one tint to another, is scarcely more marked or sudden, than is the case in some of Titian's pictures. These considerations may perhaps be sufficient of themselves to justify the opinion that the colouring of an Early English glass painting is more calculated to produce a grave and solemn effect than that of a cinque cento one; but in acceding to this opinion we ought not to overlook the fact, that the tone of colour of an Early English glass painting is cool, and that the tone of colour of a cinque cento glass painting is warm, and that a cool tone of colour of itself has a tendency to produce a grave effect, and a warm tone to produce a gay effect. If these views are correct, it follows that we ought not only to continue to employ for the windows of 12th and 13th century buildings, glass paintings similar to those of the 12th and 13th centuries, as regards the tone and principle of the colouring, but that we ought to glaze in a

similar manner, the windows of all other buildings which can be said to possess an air of gravity and solemnity equal to that of a 12th or 13th century building: using of course, weaker colours, warmer tones, and a more elaborate mode of execution for the windows of buildings in a less severe style. Some people are of opinion that in no style but the Gothic can so solemn an effect be produced, but it seems to me that the solemn character of a building, depends rather on its plan and arrangement, than on the style of its details. A Norman cathedral is as solemn as a Gothic one, and parts of the Coliseum at Rome are, I am told, as gloomy and solemn as the aisles of a Norman building. The rule therefore might well apply to certain ecclesiastical buildings in the Roman style of architecture, and I see no reason why it should not equally apply to certain ecclesiastical buildings in the Greek style: certainly these buildings, owing to the simplicity of their plan, do not possess the gloomy effect of a Gothic cathedral, but the extreme severity of the architecture imparts to them an air of gravity and solemnity, which I apprehend is rarely equalled by a 12th or 13th century building of corresponding dimensions.

I am quite aware that the employment of rich and deep colouring in windows has a tendency to diminish the apparent size of a building, and I am ready to admit that it is to a fear of producing this result, that we may attribute the modern practice of decorating the windows of a Greek building, with glass too faint in its hues to rescue it from the imputation of washiness. But it is by no means necessary to go into the opposite extreme. A glass painting entirely composed of white glass, would harmonize with the character of Greek architecture equally as one principally composed of coloured glass; provided that the white glass was, like that of the 12th and 13th centuries, solid in appearance, and had a rich cool tone. And even when the employment of a larger proportion of coloured glass might be desirable, it would always be possible to make the window recede from the eye, by using in it a predominating quantity of blue and white. But whether the advocates for powerfully coloured, or for white windows, as being most in keeping with the character of a Greek building, are right, I trust that all will agree in preferring rich tints to poor ones. Had the ancient Greeks glazed their windows, we may be certain that they would have used glass of rich tint, whether it was white or whether it was coloured. For amongst all the ancient Greek glass vessels that I have examined, I have never met with any of a poor tint, or flimsy appearance in point of colour or texture of the glass. And indeed so closely does the glass composing these remains resemble in its appearance and chemical analysis, the window glass of the 12th century (from which that of the 13th differs but little) that were I desirous of forming an idea of what Greek window glass would have been like, I should endeavour to call to recollection the tints of Suger's glass at St. Denys, or that of the glass in the W. triplet of Chartres. And besides, the remains of strong colour used in the decoration of ancient Greek buildings, leads to the inference that the ancients, had they used window glass at all, would have employed that possessing a rich tint, from choice as well as necessity. We are still less without authority to guide us in regard to the design for windows proper for ecclesiastical buildings in the Greek or Roman style of architecture. The views I have expressed with reference to the colouring of these windows, must confine me to an advocacy of a simple flat system of representation, because pictures composed on the principle of representing depth, cannot properly be executed in glass entirely consisting of strong rich tints. The only attempt I have hitherto seen at designing windows for a Greek building, is at the Church of St. Vincent de Paul at Paris. But however worthy of notice these windows may be as an embodiment of a new idea, they are neither sufficiently delicate in design, nor simple in execution, to serve as models for our imitation. It is very possible that this defectiveness may be in a great measure attributable to the thinness and watery character of the glass of which they are composed, and to the efforts of the artist to disguise the badness of the material by a more elaborate execution; but such expedients are no longer necessary, since as I have before informed you,* the manufacture of 12th century glass has been

* See paper "on a revived manufacture of coloured glass used in ancient windows," read at the Ordinary General Meeting of the Institute, 14th June, 1852, and published in the Transactions.

revived; and which I have always considered the more fortunate, on account of the use that might be made of it, in the embellishment of classical architecture, consistently with which, unlike the Gothic, art may be fully developed. There can be no doubt that valuable hints might be derived from an examination of the designs of ancient sculpture, and even of tessellated pavements. Indeed classical designs, admirably adapted for glass paintings, are engraved from sculpture in Pistolesi's Vatican, the most remarkable one is given in the 2nd vol, plate 3,* These designs consist of figures and ornaments in one plane, and therefore if executed in glass, as I have recommended, would a good deal resemble some of the works of the 12th and 13th centuries. These mediæval works, must appear to the most careless observer to be defective in many respects, particularly in relief. When viewed closely, the intention of the artist to bring out the various projections of the figure and drapery, by means of strong black lines, is often admirable, especially as seen in the heads of the figures; but, sometimes from want of boldness, sometimes from a want of knowledge where to place the shadow, early English figures in glass, when viewed from a little distance, are too apt to appear like flat surfaces; quite as flat, if not more so, as the men and horses appear to be in those copies of the inner frieze of the Parthenon, which, placed in situations distant from the eye, and exposed to the influence of full light, are used to decorate the outsides of some of our public buildings. I am far from agreeing with those who contend that no greater relief ought to be imparted to a simple flat glass painting, than is given to those flat relievi from the cella of the Parthenon. For those who urge such views, seem to have entirely overlooked the original situation of these relievi, placed where no direct light could reach them. To use the words of one of our most accomplished artists: "it is a great mistake to suppose that the flat style of relief was intended to appear flat, and it is a great mistake to apply it in situations, as in the open air, where it must appear so, and be indistinct besides."† In accordance with this authority, I will venture to say, that quite as much relief ought to be given to the figures in the simplest and flattest glass painting, as is given to the alti relievi in the metopes of the Parthenon, which were intended to be seen in the open air, and from a distance. I throw out these observations however, rather with reference to those who may be about to design simple flat glass paintings for mediæval buildings. For since I am perfectly sure that none but first-rate artists can design windows fit for classical buildings, I may well be content to leave the matter entirely in their hands: and can only express my surprise that a field so favourable to a display of the highest art, should have been so long neglected. Flaxman's labours sufficiently shew the possibility of employing the exquisite language of the ancients to express true christian sentiment; and some of his choicest designs might advantageously be reproduced in painted windows for classical buildings, were it only by way of proving to the public, what works of art painted windows might become in competent hands.

I shall trouble you with but few remarks on the selection of glass paintings for buildings in the Palladian style of architecture, in which I would include all Wren's churches, and even St. Paul's itself; for though that building has in parts a Roman severity, its interior in particular, bears many marks of the taste of the 17th century, especially in the ornamental details. Such buildings taken on the whole, are less severe in character than true Roman or Grecian buildings, and therefore would seem to require a corresponding relaxation in the character of their painted windows. In my opinion, no greater mistake is committed than when a stiff Byzantine style of decoration is applied to the windows of a Palladian building. I have heard it defended on the ground that since such glass would harmonize with the character of a Roman building, it ought equally to harmonize with the character of a Palladian one—because both styles of architecture have a common origin—in the old Roman: an argument which is at once disposed of by the remark, that the Romanesque style betrays its more immediate origin, in the Greek character of its

* "Il Vaticano descritto ed illustrato da Erasmo Pistolesi,"—Roma, 1829; see also vol. 5, plate 81, and vol. 2, plate 4.

† "Contributions to the Literature of the Fine Arts," by Sir Charles Eastlake, Pres. R.A., p. 104.

ornaments, and some of its mouldings, from which character the Palladian is free. I have also heard it defended on the supposed necessity of imparting a more religious air to a Palladian church. But surely there must be other and more legitimate ways of increasing the solemnity of a building, than by the introduction of incongruous ornaments and decorations, which oppress the architecture by their severity. Who would think of encrusting the walls of St. Paul's Cathedral with stiff Byzantine mosaics? I believe that it is amongst the works of the cinque cento period that the true models for painted windows suitable for Palladian churches are to be sought. Amongst these works, as has been remarked, many varieties of design and character may be seen. Some are more solemn and grave than others, but the blended, and comparatively undecided colouring of even the most simple, renders them less solemn and severe than the ordinary works of the 12th and 13th centuries. In most matters of detail also, cinque cento glass paintings accord with Palladian architecture. So that on the whole, the cinque cento style of glass painting, as developed in its best specimens, seems more suited than any other known style for the windows of Palladian buildings.

In adopting this style, the glass painter, as before-stated, is by no means confined to the use of pictures having receding backgrounds, but may use as flat a composition as a line of well relieved figures, placed in front of a sheet of tapestry: or even, in small works, or in the accessory parts of greater works, would find authority for the employment of well relieved figures on perfectly flat coloured grounds. The use of receding pictures in painted glass in any building, of any style, has however been strenuously objected to; and the present seems a good opportunity of inquiring a little into the validity of the objection.

It proceeds, as far as I can understand, on two grounds. The first being, the supposed unfitness of the material for any sort of representation more pictorial than the mosaics of the 12th and 13th centuries. The second, the supposed impropriety of representing a receding picture on the wall of any building. In support of the first ground of objection, we are told that a glass painting reverses the conditions of nature, by making the lights transparent, and the shadows opaque; that the violence of its colouring is wholly opposed to pictorial effect, and that to bound objects with black lines is reprehensible on every artistic consideration. The first of these arguments is at once disposed of by the observation, that we have nothing to do with anything but the *effect* of a glass painting; and that when the material is, like that of the cinque cento period, of a horn-like texture; the high lights do *not* appear to be less solid than the shadows.

With regard to the two other objections, I admit that they would be unanswerable, if it was true that an artist was precluded from painting a picture under any other than the most favourable conditions. But to assert this would be to fly in the face of all authority—and what is worse, to contradict all experience. According to such a rule, Raphael was blameable for making designs such as the Cartoons, to be worked in tapestry—"a mode of representation," says Sir Charles Eastlake, "which in the early part of the 16th century was far from exhibiting even the comparative force of colour, and light, and shade, which it afterwards attained." He should, according to the above rule, have condescended to no means of representation less complete than what oil painting affords. Nevertheless, his availing himself of such restricted means of representation, which doubtless was imposed on him by some necessary condition, so far from being made a matter of imputation, has but increased the reputation of the artist. To use again the words of Sir Charles Eastlake, whose admirable Essay on the Styles and Methods of Painting, should be carefully read by those who interest themselves in glass painting,—“With a view to such faint transcripts (the tapestries) the great artist worked. He knew that his drawings would be transferred to them, and that in the tapestries alone, possibly, his designs might live. Distinctness was nevertheless attained without any sacrifice of such of the proper attributes of painting as were compatible with the means employed, and without any violation of probability. When we consider the great qualities which were combined with

these requisites,—when we find that such apparently unpromising conditions had the effect of raising even Raphael above himself, we can hardly refuse to admit, that a due employment of limited means of representation may at least invite attention to the most important attributes of art.”* Unless therefore the conditions of glass painting are so opposed to pictorial effect, as to render the attempt to produce it nugatory, I can see no possible reason for an artist declining to fill the windows of a building with pictures, in which the art of representation is carried further than in the glass paintings of the 12th and 13th centuries. In many cases it might be extremely desirable that he should do so—for there are subjects, very proper to be represented in places of worship, which are either wholly incapable of representation in a simple flat style; or when attempted to be so represented, only prove how easily the line which separates sublimity from absurdity may be overstepped. But when pictures in painted glass, representing receding objects, actually do exist, in the contemplation of which we forget the limited means the artist had at command, and in which excellencies are discovered, such as are unattainable except in a painted window; the ground of objection to which I have addressed myself appears to fail altogether.

The remaining objection, that it is wrong to represent a receding picture on the wall of a building, and consequently in a window, the glazed surface of which is but a continuance of that wall—seems to rest less on a consideration of facts, or the dictates of our external senses, than on a sort of mock philosophy, which seeks to escape laborious investigation, by the enunciation of a “principle”—than which, by the way, nothing is more easy. It may be conceded that to carry a receding picture all round a room produces an ill effect. But pictures, though representing the effect of depth and distance even almost to illusion, are admitted to be allowable, provided they occupy only a portion of the wall, either by being hung against it in a frame, or by being actually painted upon it,—the latter sort indeed can plead the testimony of ages in its favour. If then a glass painting should have the illusion of distance, it would be unobjectionable,—because, necessarily, it could occupy only part of the side of the room or building containing it. And as we are accustomed to see out of a building, by looking through its windows, those who mistook the painting for a real object, might easily stretch the imagination a little further, and conclude that it was some object placed outside the building, until its unreality became apparent from the figures continuing to remain motionless. But, in truth, I suspect that no one ever mistook the representation of any object in a painted window, not even a landscape, for the reality, or except whilst his attention was exclusively devoted to the painting, imagined that his view extended beyond the limits of the building: a feeling which for the moment might be equally excited by the contemplation of a picture hung in a frame against the wall. The instant the glass painting was regarded with reference to the building, it would be perceived to be nothing else than a coloured superficies, whose plane lay in the same direction with that of the wall in which it was inserted. It might indeed sometimes happen that for the sake of preserving distinctness at a very great distance, a glass painting, in which figures were represented on a flat ground, would be preferable to one having a receding background. But I think that the glass painter need be deterred by no other consideration from employing a receding design, if he thought proper. Indeed, a glass painting having a sky or landscape background, such as we meet with in good cinque cento examples in general, would be peculiarly suitable for a window at the end of a building, on account of the retiring nature of most of its hues. I conclude therefore that in the preparation of painted windows for classical edifices, the artist has the choice of a more or less severe style of representation, to be used according to the character of the building he is required to decorate; and that the type of the one style is to be found in the remains of 12th and 13th century mosaics, and that the type of the other is to be found in the glass paintings of the second quarter of the 16th century. The artist might, I apprehend, be guided by similar principles in preparing painted windows for buildings in the Gothic styles.

* “Contributions to the Literature of the Fine Arts,” by Sir Charles Eastlake, p. 133.

I have already stated my belief that the glass paintings of the 12th and 13th centuries are most in harmony with the architecture of those respective periods, and therefore think that such of those works as most consistently carry out the simple flat style of representation ought to be regarded, with but few exceptions, not indeed as objects to be reproduced in copies, but as guides to assist the artist in forming new and original designs. The principle of an ancient composition might be more strictly adhered to now than at any former period, on account of the revived manufacture of the window glass of the 12th century; but this recommendation would by no means involve the necessity of copying the object itself. Indeed nothing is more thoroughly opposed to sound sense, and good taste, than a mere servile copy of an ancient glass painting, or a copy with such trifling modifications as to be little else than a servile copy. If intended as a counterfeit, it must fail in its object—for none but the inexperienced are likely to be deceived by it—and once known to be a counterfeit, it would lose all interest from association with bye-gone ages. If intended to pass for nothing more than a copy, under the bonâ fide impression, that nothing except a copy of ancient painted glass will harmonize with Gothic architecture—it serves but as a cover for indolence—it can advance nothing, because a copy is sure to fall short of the original in all real merit; and besides this, its production amounts to an unconscious satire on Gothic architecture, when we consider the imperfect state of the art of representation as displayed in ancient windows. The only true course is to treat every modern work in painted glass, as an original work of the 19th century,—and as such, to test it according to intelligible rules of taste. The inquiry ought no longer to be confined to the narrow issue of conformity with some ancient authority, but should extend to a consideration of its intrinsic merit as a work of art, and its extrinsic merit as being in harmony with the architecture with which it is associated. To prescribe so wide a field of inquiry might, indeed, prove inconvenient to certain critics, but would certainly tend to a more zealous investigation of the principles of ancient art than heretofore, and to the production of works more worthy of the 19th century: in short, it is by this means only that any progress can be made. A 19th century window, designed for a 12th or 13th century building, ought not only to harmonize with the architecture in the quality and treatment of its colouring, but besides restraining conventionality within due bounds, should likewise be free not merely from the bad drawing, but from the quaint and contorted attitudes of the figures of the 12th and 13th centuries; attitudes which, however fashionable they might have been at that period, are shocking to our present tastes and feelings. It should, in fact, reproduce nothing but the art of that period, the genuineness of which will only appear the plainer, when the film of bad taste and deformity is stripped from it, through which we are now obliged to penetrate before we can fairly see it. I should add, that in designing a window for a 12th century building, the artist can never do wrong in going at once to the fountain head, and correcting his taste by the remains of classical art, whose influence is so easily recognised in the glass paintings of the 12th and 13th centuries.

A consideration of the colouring best suited for the windows of a 14th century building presents an interesting subject of inquiry, but into which I cannot, for want of time, particularly enter. The glazing of the 14th century, until about the year 1380, in respect of the quality and disposition of its colouring, holds in general a sort of middle place between the rich mosaics of the 13th century and the paler picture glass paintings of the 15th century. Its individual colours being as cool, and almost, if not quite, as powerful as those of the 13th century—but being intermixed with a much larger proportion of white glass, and used in broader masses. But this difference in the character of the colouring seems attributable rather to the nature of the designs which became fashionable in the 14th century, than to any definite abstract principle. But however this may be, there is one lesson to be learnt from the works of the 14th century, if not from those of the latter part of the 13th, which is—that the glazing which chiefly consists of white glass is more favourable to the effect of window tracery, than that which consists of a mass of intensely rich colours. For the latter tends to confuse the tracery, unless indeed the direction of

the principal lines of the glass composition are strongly opposed to the lines of the stonework, in which case there is a sufficient contrast between the stone tracery, and the deep coloured glass, to render the former perfectly distinct. Thus the mullions and tracery come out strongly in some of the clerestory windows at Bourges, and in the windows of York Chapter House, where the glazing is principally white, but are not so easily made out in the windows of the Sainte Chapelle at Paris, which are filled with richly coloured glass. On the other hand, the mullions of the southern rose at Chartres, which is likewise filled with richly coloured mosaics, shew themselves distinctly—as appears from the diagram I now exhibit. Here the principal lines of the stonework diverge, like rays, from the centre of the window, whilst the principal lines of the glass composition form concentric circles. The star-like effect of this, and many other rose windows of the 13th century (the north rose of Nôtre Dame at Paris, is another example); thus being produced by the opposition of two distinct designs,—one of which, the stone design, appears as if it was laid upon the other. If this consideration should lead to the conclusion that glazing, principally consisting of white glass, is best suited for the windows of buildings in the Decorated style of architecture, there can be little doubt, I apprehend, that the best designs would be those consisting of pattern-work painted on white glass, of which there are numerous and beautiful examples in the Cathedrals of York and Exeter, Merton Chapel, Oxford, and other places, with or without the enrichment of inserted panels, containing groups, or single figures, on stiff coloured grounds, executed in the simple flat style before-mentioned. I would on no account advocate the use of figures and canopies, because the stiff character of the colouring, which does not materially differ from that of the 13th century, is unfavourable to such a display of light and shade as is necessary to make the canopies seem as if they projected forward. I have heard the flatness of decorated figures and canopies defended on the score of their resemblance to some of the published outlines of the German engraver, Retsch; but these outlines are only intended for near inspection, by which alone, the varying thickness of the outline, which produces the effect of light and shade, can be appreciated. At a distance, these designs would, of course, be invisible; or if enlarged in painted glass, as I have also heard recommended, would appear flat and thin: just as a copy of a 14th century monumental brass would look if executed in painted glass.

The change in the nature of the material in 1380, or thereabouts, and the substitution of glass, such as we see used in the works of the 15th and 16th centuries, for the deep intense tints previously employed, is, like many other points connected with the history of an art, one on which no light has hitherto been thrown. It is but a conjecture that the change was brought about by the glass-makers in Germany. But I think we may conclude, from the fact that glass painting was becoming more pictorial just before the change in the material, and that it became still more pictorial after it, that the lowering of the different tints in depth, was intended to second the efforts of the artist to produce glass pictures in preference to glass mosaics. One is tempted to infer the existence of some harmony between the character of the architecture, and the delicate tints and silvery tone of the glass of the 15th century, from their having been so long associated together. And, in one respect, the glass is no doubt well suited to the architecture. For even the most elaborately painted window is, owing to the lightness of its hues, never confused with the stonework. And experience has abundantly shewn that the effective pictures of the 16th century harmonize as well with the architecture of the 15th as the imperfect productions of that period. There is no apparent difference between the architecture of the windows of Fairford Church, Gloucestershire, and that of the windows of churches quite half a century earlier; and yet the 16th century glass, with which these windows are filled, is in perfect harmony with the character of the building. I therefore think that windows for 15th century buildings should be designed on the model of the glass paintings of the 16th century; in which case the artist might consistently employ canopies, if he thought proper. The most splendid Gothic canopies in glass, that I have ever seen, are in two of the windows of Munich Cathedral; one is dated 1503.

These canopies are so painted as to appear like what they profess to be—hollow niches. As a general rule it appears more satisfactory that one scale of figures should be preserved throughout a window, than that the size of the figures should be regulated by the sizes of the lights they occupy; as in most Gothic examples. In the cinque cento period the uniformity of scale was preserved, not unfrequently, by the employment of angel boys, instead of full grown figures, to fill the smaller tracery lights. At Fairford, and other places, the expedient adopted is the use of demi figures in the tracery lights.

In the 15th as well as in the 16th century, it was a not uncommon practice to extend the design of a glass painting beyond the limits of a single light. In some instances the entire window is filled with a single picture, which is spread over the whole opening, independently of the mullions. So great an outcry has however been raised against this practice, that it seems worth while to say a few words in justification of it. In the first place, there is not, I conceive, a greater violation of principle committed, in laying as it were the design of Perpendicular tracery work, over the design of a 15th century picture in glass, than is committed in laying the design of a 13th century rose window over the design of its glazing. The stonework of the window sustains no injury of effect, on the contrary it is rendered more distinct by the opposition of its design to that of the glass. Neither is the glass painting injured by being cut by the stonework, for as remarked by a member of this society on a former occasion, the force of imagination is such, that the design may be preserved in all its unity, through any number of lights: an observation which, I think, will be admitted to be true by those who have been in the habit of looking at such works with an unbiassed eye. But the practice may be defended on another, and perhaps less questionable, ground—on the score of necessity. Our ancestors were in the habit of representing in their windows vast numbers of legendary saints: but modern practice is in general so opposed to this, as in effect to limit the choice of the artist to representations of our Saviour, the four Evangelists, the twelve Apostles, occasionally the Virgin Mary, and some of the Prophets and Patriarchs. I believe that I am speaking within compass when I say that his choice does not extend beyond three dozen single figures. Consequently monotony is inevitable, unless recourse is had to groups of figures. Here indeed the means of selection is almost unlimited. Flaxman declares (*Works*, p. 337), that it may be affirmed “without danger of exaggeration, that many hundred subjects are to be found in the sacred writings, which, being ably designed, would be *new* to the beholder.” But in order to ensure a sufficient scale for the figures, the group must not unfrequently be extended beyond the limits of a single light. Upon the ground of necessity, therefore, we may well justify the carrying a glass picture across a window, to a certain extent irrespective of the mullions. And I should perhaps add, that when we consider that painted windows by their size might not unfrequently offer a field for the talents of the historic painter, it seems unadvisable to scare artists from it, by imposing conditions, which were often broken through by the mediæval painters themselves.

In conclusion, I will repeat what I stated at the outset, that I claim no infallibility for any of the views I have advanced. I am conscious of having approached delicate ground more than once; especially in the course of my remarks on the sort of glass paintings best suited for buildings in the classical styles. On this point I consider that I have but raised questions which wiser heads than mine must solve. My object will have been accomplished if I have added but one grain of information to the common stock: or if I have succeeded in proving that there is no mystery in glass painting; that it is a branch of the Fine Arts, distinguished from others only by certain conditions, and that the same sober rules of criticism equally apply to the productions of the glass painter. To take a familiar instance—we sometimes hear it disputed whether the flesh ought to be coloured or left white, in a glass painting; the opponents of tinted flesh urging the impossibility of imitating nature exactly in this respect. The answer is obvious enough. The whole colouring of a glass painting is highly conventional, whether it be of the draperies, of the flesh, of the sky, or of any other object; still so long as it does not exceed the limits of conventionality—a point to

be ascertained only by observation and general opinion—the eye and imagination are satisfied. We should be startled and disgusted at seeing flesh painted green or blue, but the complacency with which pink or white flesh in a glass painting is regarded by the generality of mankind, is a sufficient proof that neither of those tints contradicts nature too violently; and therefore, that the artist does not exceed the limits of conventionality in using either white or tinted flesh, at his discretion. The wide range of this paper, and the necessity of confining its length within reasonable limits, has of course compelled me to touch on several topics in a very cursory manner; and especially that relating to the actual mode of executing a glass painting, on which the argument in favour of the mosaic system almost entirely depends. However as I went into this subject at great length, in a little work which I published in 1847,* and of which there is a copy in your library, I must refer those to it who are inclined to pursue the matter further. It may seem superfluous to those who have read this book, to assure you that there is a perfect consistency between it and such views as I have just expressed; but as certain writers are in the habit of taunting me with inconsistency, I may as well state that the only foundation for the charge is this—That perceiving at the time when that book was written, that modern copies of the 13th century windows, besides being very raw in colour, were, owing to the extreme pellucidness of the glass then in use, thin and poor in effect—the most favourable examples never having a more imposing air than a *veneer* of an old window might be expected to have, and that the process of antiquating the glass, that is dulling it over with enamel brown in imitation of the effect of age, only produced dulness without imparting depth—I ventured to suggest the adoption of shadows, such as we see in cinque cento work, as well as a broader style of colouring than was used in the mosaics of the 13th century, as a means of correcting the flimsiness, without destroying the brilliancy of the material, and at all events of giving *power* to the work. And that since the manufacture of the 12th century glass has been revived, I have advocated a nearer approach to ancient precedents, both in the execution of the painting, and the method of its colouring. I trust this brief explanation will finally dispose of the charge to which I have alluded; a charge which never would have been made, any more than the absurd misrepresentation, that I have at any time recommended the universal employment of the cinque cento style, details and all, had it not been for those writers' ignorance of the subject on which they professed to write, and their consequent inability to comprehend any argument in relation to it, which is founded on general views. To you, gentlemen, I am indebted for the patience with which you have listened to so long and dry a discourse.

The Chairman, Mr. T. H. WYATT, V.P., having adverted to the great interest and importance of the subject, especially in the novelty and boldness of some of Mr. Winston's views, suggested that the discussion of the paper might be advantageously postponed until the next meeting, when he hoped that gentleman might be able to attend.

Mr. WINSTON having assented to this suggestion, it was agreed that the discussion should take place at the Meeting on the 12th of December.

M. ROCHAS exhibited some specimens of stone, prepared and hardened by a new process, to resist the effects of the atmosphere.

Mr. G. G. SCOTT, Fellow, suggested that a Committee should be appointed by the Institute to consider thoroughly the subject of the prevention of decay in building stone. Architects were obliged to use soft stones, which sometimes proved durable in country places, whereas they decayed rapidly in the metropolis. Caen stone had not been found to stand as it did in former times; and if, as M. Rochas stated, he was able,

* "An Inquiry into the difference of Style observable in ancient Glass Paintings, with Hints on Glass Painting, by an Amateur," p. 238, et seq.

by a very simple and moderately expensive process, to render it durable, it was certainly a most important discovery. He understood that the process was being used in the works in progress at Notre Dame, in Paris; and if successful, its adoption was more necessary in this country than in France. It was highly important that its value should be tested by the Institute most fully.

Mr. GODWIN, Fellow, also urged the importance of the subject, and the propriety of referring it to a Committee; which might also consider the project of Mr. Hutchinson for the same purpose, which had been tried at Tonbridge Wells.

Mr. JENNINGS, Fellow, believed Mr. Hutchinson's project had not succeeded. Its object was rather to keep out damp than to preserve the stone.

Mr. C. H. SMITH, Visitor, concurred in the importance of the question, and stated that there were now in London many ship loads of stone which ought never to have been imported, and which had only been brought here from mistaken feelings of economy. There were many plans for arresting decay in stone, and some of them were practicable and desirable upon a small scale; but there was great difficulty in applying them extensively.

Mr. SCOTT alluded to another process, consisting in the employment of an oleaginous composition, which he had some time ago suggested to the Dean and Chapter of Westminster.

Mr. BURNELL, Visitor, observed that the attention of the Committee should not be limited to the different processes referred to, but they should ascertain, if possible, the *causes of decay* in stone; inasmuch as the same kind of stone was often employed in different localities with very different results.

ON THE APPLICATION OF PAINTED GLASS TO BUILDINGS IN VARIOUS STYLES OF ARCHITECTURE.

Being a Discussion held at the Royal Institute of British Architects, December 12, 1853.

THE CHAIRMAN, Mr. T. H. WYATT, V.P., invited Mr. Trotman, Visitor, to give some explanation of the drawings exhibited by him.

Mr. TROTMAN proceeded to describe the subjects in chronological order. The first was one of a series of four subjects relating to the history of Christ, from the Church of Rivenhall, Essex, which had been procured from Tours some years ago by the present Vicar, for the decoration of the church. These specimens dated from about the beginning of the 12th century. The whole of the ground colour was a rich bright blue; a quantity of green was intermixed with this in the figures, and great relief and brilliancy was given to the design by the introduction of characteristic lines of white. Mr. Trotman next referred to similar specimens from Canterbury Cathedral, and to four subjects from York Cathedral, the most perfect, out of seven, representing the corporeal Acts of Mercy—Giving shelter to the Houseless, Visiting the Sick, &c. Two large drawings of windows in the Church of West Wickham, Kent, representing the Virgin and Infant Saviour, and the Virgin and St. Anne, were next noticed; these being of the latter half of the 15th century. A Nativity from Great Malvern Church; one of the heraldic badges from the East end of Henry the Seventh's Chapel; the Visit of the Queen of Sheba to King Solomon, from Fairford Church, Gloucestershire; and an interesting specimen from the Hammermen's Chapel in the Cowgate, Edinburgh, representing the National Arms of Scotland ("the Scottish Lion"), were then referred to and described; and Mr. Trotman further directed attention to a series of small drawings of painted glass from the Continent, including specimens from Paris, Rouen, Brussels, Cologne, &c. Mr. Trotman expressed his concurrence in the views of Mr. Winston generally, and regretted that some false principles should have been promulgated on the subject of glass painting by Mr. Redgrave, in the Catalogue of the Contents of the Museum of Ornamental Art, that gentleman having objected to the introduction of shadows, and observed that "glass painting should consist of flat tints without shadow." On the contrary, he (Mr. Trotman) considered that if shadow were to be omitted, there must be an end of glass painting; and certainly the folds of drapery, &c., could not be better represented by outline than by shadow, especially as painted windows must be seen from a great distance. The real question was, to what extent the principle of shadow and rotundity should be carried. Some of the medallions in Canterbury Cathedral were in simple outline, whilst the East window of St. Bride's Church (the Descent from the Cross, by Muss, after Rubens) was remarkable for depth of shadow; and each of these alike failed to realize the resources of glass painting. The object to be attained was the highest degree of brilliancy consistent with a high degree of art; and he therefore could not sufficiently admire the sentiments of Mr. Winston, who had given a severe blow to the merely antiquarian view of the subject, and to the fallacy of direct imitation of Mediæval glass painting. Ward and Nixon, in their work at Westminster Abbey, were to be commended for not adhering too rigidly to the old models, although they had not succeeded in developing all the resources of the art. As a general principle, in order to insure that brilliancy which glass offered, it was necessary to treat every subject with considerable subdivision, and great attention to detail. In some modern glass painting much of the interest was lost by a neglect of accessories and details, and the modern glass at Cologne Cathedral was objectionable in this respect, as it consisted of single figures with large masses of drapery. By subdivision he meant a more complicated style of composition than was necessary in any other kind of painting. Thus, the Church of St. Vincent de Paul, at Paris, possessed some of the finest specimens of modern glass; but from the figures being too colossal, and occupying each one window, the subjects were less interesting, and less brilliancy was obtained, than a different treatment would have insured. The effect of colossal figures in

glass painting tended to diminish the apparent magnitude of the building, and was exemplified at the East end of the Chapel of Eton College, where the windows of Mr. Willement had an injurious effect. Upon the whole, he considered it would be very wrong to study the specimens exhibited with a servile regard to precedent, but rather as offering so many steps towards the attainment of a good and effective style. The human figure must be considered essential, either singly or in groups, as windows representing only foliage, &c., could not be interesting, and should rather be classed as ornamentation than art. The subjects should be on as small a scale as was consistent with distinctness, and, so long as the necessary brilliancy was not detracted from, there was no limit to the application of shadow. Useful hints might be taken from sculpture in relievo, and from such works as the bronze Gates by Ghiberti, at Florence, care being taken to render the figures important and the accessories subordinate.

The Rev. J. L. PETIT, Honorary Member, concurred with Mr. Winston, whose object, it appeared, was to combine the merits of the glass of the 12th and 13th centuries, with a degree of art and beauty not then obtained; and in so doing he would not violate the principles of that era, when the artists got the best models and drew as well as they could. Servile imitation should be scrupulously avoided, and if works of art of a high character were unsuited to Gothic buildings, then the Gothic was not the style for the age. The architect should make himself independent of the painter and the sculptor; but when their aid was offered in the finest art, he should be able to exalt that art, and so to place the specimens of it that they should appear exalted even in their subordination to the architect. Thus the Grecian, the Roman and the Italian styles, admitted of the application of art in its highest character; and so the Mediæval architecture admitted the best specimens of art that could then be obtained. If, on the contrary, at the present time Gothic and the highest art were incompatible, that style ought not to be pursued. Architects should endeavour to revive, to modify, and improve it; but if they could not make it a noble style, let it be abandoned.

Mr. E. T. PARRIS, Visitor, drew attention to the cartoons of Raffaele as being, in his opinion, composed upon principles similar to those which should regulate glass painting. In those works every relief was gained by an opposition of colour, rather than by shadow; and, as in the best stained glass, the horizon was very high, its line being always broken by colour or form of some sort—in one instance by a house on fire, the object of introducing which could only proceed from some artistic principle. He fully agreed with the remarks of Mr. Winston. Many painted glass windows had been erected from his (Mr. Parris') designs, but he was generally trammelled by the person who had the order. He had declined the work at Westminster Abbey, executed by Mr. Nixon, for this reason.

Mr. PAPWORTH, Fellow, observed that the discussion had been directed rather to the best styles of glass painting for Mediæval architecture, than to "the proper application of painted glass to buildings in various styles of architecture." The question to be laid before them by Mr. Winston, was whether they ought to have any stained glass at all. Stained glass either was or was not a necessity to the architect, and it would be well to settle this as a principle. In the majority of the works of modern architects the question was a difficult one. They could not all build churches and fill the windows with stained glass, or decorate old churches in the same way, their business being rather with a great variety of public and domestic buildings; and the difficulty was whether painted glass was applicable to domestic uses, and if so, what style should be adopted. The reply to this question would answer the previous enquiry—whether they were to have painted glass at all. He considered there was a great deal of merit in that kind of glass which had been largely introduced since 1800, consisting chiefly of ground glass, with arabesques and other ornaments painted upon it. Probably Mr. Winston would state whether he thought that kind of painting applicable to the wants and purposes of the present day.

MR. ALFRED BAILEY observed that there was one variety of Mediæval painted glass which had not been

referred to. This was to be found in the minor towns of Central Italy, and appeared to have been executed late in the 15th century, and designed on totally different principles to any other kind. They resembled in general design the English glass of the 13th century, but instead of the colours being arranged in small lines, they were introduced in large masses, giving a broad effect of colour. Figures were introduced but sparingly, and generally small; which was remarkable, considering the perfection attained in the Fine Arts at that period. Mr. Bailey referred to specimens at Arezzo, Perugia, and Assisi. With regard to the question of the style of art suitable to painted glass, he believed that a finished pictorial composition was not suited to that material. In S. Petronio, at Bologna, two of the grandest figures designed by Michael Angelo were introduced in stained glass, with a great deal of light and shade, and produced a most unpleasant effect. Mr. Winston did not object to shadows, perspective, and even landscape back-grounds, but it required great study to know what effect a picture would have, and whether it was a fit subject to permit the passage of light. None of our best artists would like a good picture to be placed in the situation of a painted blind. Architects often neglected to consider where they should place painted windows, and a very bad effect was sometimes produced by having them at the level of the eye. A grand and broad effect of colour should be sought for rather than a result resembling patch work; and the architect should especially remember the importance of painted windows, as striking the immediate attention of the spectator on entering the building; and, consequently, if these were too much elaborated, they must detract from the effect of the building itself.

Mr. TWINING, Visitor, was of opinion that stained glass should not be made to compete with oil paintings, but should be rather of an ornamental character. Painted windows being generally placed at a considerable height, were not adapted by position to receive representations of landscapes,—especially of flat scenery; and moreover architectural subjects seen in an elevated position must be represented by false perspective. The representation of groups on different panes was objectionable, because the metallic slips which formed their outlines were necessarily of the same thickness throughout.

Mr. HESKETH, Fellow, called attention to some books containing a series of original illuminations from MSS. on vellum, collected by Major Macdonald in Arabia, Syria, and Italy. The beauty of these illuminations, and the principles upon which they were designed and coloured, admirably adapted them for imitation in glass painting. In reference to paucity of subjects for stained glass, he might suggest the metaphorical subjects abounding in the Scriptures,—such, for instance, as the meeting of Righteousness and Peace; and many others, which Flaxman had mentioned as never having been treated by artists.

Mr. TALBOT BURY, Fellow, regretted that a sufficient amount of talent had not hitherto been brought to bear upon glass painting. He agreed with Mr. Winston that those designs in which the light was centralized were failures, because the objects represented must be transparent or semi-transparent. One obstacle to enlisting talented artists as glass painters arose from the mania for collecting specimens of old glass of any kind, and putting them together as “ruins,”—or copying and imitating them. Again, a first-rate painter would not be fettered by a glass cutter, or by any rules or dogmas as to the style of drawing he should adopt. The advice of the artist was too often neglected, and people would not give sufficient remuneration for his work—that was the true cause of the inferiority of the art. It had become a matter of competition, and the person who gave the most glass and the most colour for the money, was employed, without regard to merit. Individuals, committees, and the clergy, were alike ignorant of the principles of the art, and were too often influenced by a mere prejudice in favour of antiquity. He wished, therefore, that Mr. Winston’s paper could be extensively circulated, for the dissemination of good taste. So long as nine-tenths of the world preferred the barbarisms of antiquity to the finest works, he did not know what could be done to improve the art of glass painting. Mr. Bury referred to a drawing of the east window from Lincoln’s Inn Chapel, &c., as an illustration of bad taste in modern work. He agreed with

Mr. Winston that by an artist the mullions dividing a window might be overlooked; but that was not the case with others, and when, as in some instances, a canopy or other object on the glass was completely divided by a mullion, as in a German specimen among the drawings, the effect was very bad.

Mr. WINSTON, Honorary Member, expressed the great pleasure and instruction he had derived from the discussion on the subject of his paper. Not being a professed artist, he had been obliged to study the subject in a desultory way, and rather by actual observation and comparison than by deep reflection. Hence, he had not given his attention to the subject of painted glass for domestic purposes. He agreed with Mr. Trotman as to the principle of subdivision, and in his objection to colossal figures. Some of the figures in ancient windows did not appear so large as they actually were, in consequence of their skilful treatment by the artist. A figure of St. Christopher, at Strasburg Cathedral, of the 12th or 13th century, was nearly fourteen feet high; but the drapery was broken in every direction by lines of different colours, and there was little or no shadow; so that the general effect to the eye was similar to that of a mass of colours, or a regular pattern. The remarks of Mr. Parris, as to the Cartoons of Raffaele, were new to him, and he quite agreed with them. Sir C. Eastlake had also pointed out the manner in which Raffaele had adapted his compositions to their execution in a material incapable of any great effect of depth. He agreed with Mr. Papworth that ornamented ground glass had much merit. It looked somewhat flimsy; but it was very pretty, and certainly better than plain glass. It might be a question how far painted glass was suited to modern domestic habits. Mr. Winston mentioned the round patterns seen in German glass, and Mr. Powell's patent for stamping glass. The weight of this latter material, however, rendered it objectionable for a window to be raised and lowered, but it was well suited to staircase windows, &c. What he had stated respecting the flat and the rotund style of glass painting should be borne in mind; and the material should not be forced beyond its capabilities. The early MSS. certainly contained valuable hints in their illuminations. Mr. Bury's remarks on the question of the cost of good windows were perfectly true; and it was impossible to deny the superiority of foreign stained glass. The specimens in the Great Exhibition of 1851 amply proved this. These were works produced under the fostering patronage of powerful individuals. It should be remembered that not only was there an objection to pay adequately for good works, but that a vast deal of money was wasted on bad works. It would be better to have one good one than fifty bad ones. The erection of one fine window in a church was sufficient for a generation, and doing more than that in an imperfect way, was only impeding what might be better done hereafter. It was the province of architects to elevate this art by impressing its importance upon their employers; and he felt sure that there would be no want of skilful designers, if proper encouragement were offered to them.

The CHAIRMAN, in proposing a vote of thanks to Mr. Winston, concurred in the necessity of architects forcing their employers in every possible case to encourage a higher style of art. He would never himself be a party to the erection of a stained glass window, unless he had a choice both of the cartoon and the artist. Their difficulties had arisen from a combination of circumstances,—of which not the least was the fact, that the whole world professed to be critics, especially in Mediæval art, and acknowledged no judgment but their own. He took occasion to refer to the new window in Mr. Hope's church, in Margaret Street, which he described as most unsatisfactory, though he had met several persons who considered it the finest of modern specimens.

Thanks were voted to Mr. Winston for his paper and further remarks, as well as to Messrs. Trotman, Bury, and others, who had exhibited the drawings on the walls, and the Meeting adjourned to January 9th, 1854.

Royal Institute of British Architects.

Communication from the Honorary Secretary of Foreign Correspondence, January 9th, 1854.

GENTLEMEN,

I have to announce to you various events of a chequered character, which have occurred abroad since our last meeting. You will learn with much satisfaction that the Institute of France have elected our Honorary and Corresponding Member, Herr Zanth of Stuttgart, a Corresponding Member of that distinguished body; an election equally honorable to both parties: to our professional brother, as a testimony to his distinguished merits as an architect, and to the Institute of France, as evincing the discrimination with which they recognise foreign talent. A curious incident adds interest to the event: one of our colleagues, and member of that Institute, as soon as the election was decided, dispatched a message by telegraph to Wurtemberg to announce the fact. It had of course to pass, in its course of some hundreds of miles, through several States, and to incur some delay in the delivery; it, however, reached its destination in two hours, and in two more the zealous friend at Paris had the satisfaction of knowing that the welcome message had arrived, and of receiving Herr Zanth's acknowledgments for the promptitude with which the gratifying announcement had been made to reach him.

At our first meeting of the session in November last, it was my duty to communicate to you the death of our Honorary and Corresponding Member, Monsieur Fontaine. I little expected so soon to have to inform you of other losses from among those with whom I stood at the tomb of Percier and Fontaine, when I had to express to those around me your sympathy in the loss which France had then experienced—little did I think, as the venerable and accomplished Achille Leclère stood trembling, weeping, his grey hair floating in the wind, and uttering the few words to which his grief gave vent, that he was standing himself on the verge of eternity: but he, too, has followed his brother architect. On the 26th of December last his remains were accompanied to the Cimetière du Nord, amid the regrets of his colleagues, his friends and his pupils; and eulogiums were pronounced by Messrs. Raoul Rochette, Vinet, Visconti and Isabelle.

It appears that Monsieur Leclère carried off the *Grand Prix* in 1808, at twenty-two years of age—a very unusual circumstance in the life of an architect. The programme of the competition was a large establishment of public and private baths for the capital; and the manner in which he had carried out his conception was most remarkable. During his residence at Rome the studies of the young *pensionnaire* were always well chosen, and conscientiously and well executed. His restoration of the Pantheon was the crowning point of his many researches amongst antique monuments, and placed him amongst the most distinguished architects who had given their attention to the restoration of that magnificent building of the Augustan age. M. Leclère also made an interesting collection of studies on the modern edifices of Italy. A student in the celebrated school of Percier, whose taste and learned maxims extended throughout Europe, the pupil, after his return to Paris, was attached by his worthy master to the administrative department of the Conseil des Bâtimens, in whose works he took part for thirty years; and when the celebrated Professor was unable to continue his labors in the school, he entrusted them to the direction of Monsieur Leclère. These circumstances were the chief cause which prevented M. Leclère from being engaged in the erection of more public buildings; however, he executed in France many large country houses, and in Paris some of the finest houses of modern times. One of the most remarkable monuments in the Eastern Cemetery of Paris, that of Casimir Pèrier, was designed and executed under his direction. His brilliant début as pupil,

and his subsequent works as *pensionnaire* of the Academy, were followed by M. Leclère's early entrance into the Institute, where he was called upon to take part in the works of the Professors in the School of Fine Arts, who appointed him "*Archiviste*." Of a kind and conciliating disposition, full of love for his art, persevering in those principles which he believed to be the best, encouraging those pupils who were studious and distinguished, M. Leclère well deserves all the encomiums which accompany his memory to the tomb. M. Leclère presented to this Institute some very important tracings of the constructions of the Pantheon at Rome, next the portico, with a view to explain whether the portico formed a portion of the original design, or was a subsequent addition of a later period: they are preserved in our collection of original designs and drawings, which are now forming a very valuable series.

In the funeral cortège of Mons. Leclère, just noticed, you will perhaps have remarked the name of Visconti, as one of those who addressed the assembly at the grave of his friend; within one short week Visconti was himself cut off suddenly by an apoplectic fit, and borne to the cemetery of Père la Chaise amidst the grief of all France—and may I not add? of all Europe. Mons. Visconti was present on Thursday the 29th of December at the first meeting of the Commission for the Exhibition of 1855, at the Palais Royal, under the Prince Napoleon, and remained there from 1 to half past 3 o'clock; he then left, and went to his office at the Louvre with a friend, M. Semard; with him he had an animated conversation, and having to dine out, he asked for his carriage, but it being then only half past 4, and earlier than the time he usually quitted the works, it had not arrived, and he sent for a hackney carriage. M. Semard saw him into the carriage, and it drove off, and soon reached his residence; the coachman got down and opened the door, when he found Mons. Visconti quite dead.

He had just reached the culminating point of glory for an artist, by having had confided to him the completion of the Louvre, which had occupied the genius of French architects for two centuries. He had reaped the fruits of laborious and profound studies in the very highest departments of our art, by solving the problem, which seemed to present difficulties apparently irreconcilable and almost insurmountable; and he had commenced, and to a great extent carried into effect (to the height of 30 feet in some parts) with inconceivable rapidity, the outlines of his grand design, which united all suffrages, and promises to render the Palaces of the Louvre and Tuilleries the finest sovereign-residences in the world. At the same time it must be confessed that the conceptions of other architects, as Percier and Fontaine, and more recently, of Mons. Dusillon, had considerably assisted him in the solution.

I had from his own lips the following account of his appointment to this important work. He received very unexpectedly, about three years since, a notice from the officer of the household of the President of the Republic, to the effect that he would be received next day at the Elysée Bourbon at a certain hour; he duly attended, and was soon ushered into the Cabinet of the Chief of the State, by whom he was received most courteously. "It appears to me," said Louis Napoleon, "that the Palace of the Louvre should no longer remain in a condition which reflects disgrace on the Government, and it is desirable that employment should be provided for the working classes; I have therefore conceived the design for the completion of this palace, which I wish you to undertake." "Sir," replied Visconti, "I am gratified by so honorable a mark of your confidence, but I venture to remind you that Mons. Duban is architect of the Louvre, and it is impossible for me to interfere with a position which he fills with so much credit and ability." "True," replied the President, "but Mons. Duban is architect of the works of the Old Louvre; I wish you to undertake this appointment as architect of the works of the New Louvre, which are to be quite distinct, and to be a charge entirely separate, and not interfering with or superseding the other." "In that case," said Mons. Visconti, "I am quite at your command." The Prince then explained a scheme that he had himself conceived and roughly sketched, which he wished Visconti to draw out architecturally, and asked how much time would be required. When informed a month, he said "Well, in a month I shall expect you

to come, and you shall be admitted at once." At the end of that time, Mons. Visconti took the plans, and submitted them to the President, who highly approved of the manner in which his views had been carried out. Mons. Visconti then ventured to suggest that, in the course of study to which the plans had given rise, it had occurred to him that a much nobler and more desirable arrangement could be adopted, which he should wish to submit to his Highness' approval. The Prince immediately encouraged the architect to develop his views, and this he did in his succinct, clear and convincing manner, so as to carry the conviction of the President, who then asked him how much time he would require to prepare the necessary drawings. Six weeks. "Enough," said L. Napoleon, "and in six weeks bring me your project thoroughly considered." Accordingly, in six weeks Visconti again attended at the Elysée Bourbon; but, during the interval, the Republic had become an Empire, and the President Emperor. It was sufficient for Louis Napoleon to see the design which his architect had prepared; his ready aptitude seized all the superiority of the arrangements proposed, and he expressed himself perfectly satisfied. Taking out a paper from his breast pocket, he presented it to Visconti, saying, "Take this document; it constitutes you architect of the new works of the Louvre." In fact, it proved to be a formal document, signed by the proper authorities. The Emperor desired him to be ready to attend a council in a few days, and explain the plan, and to be prepared with general estimates as to the cost. Our architect, of course, was punctual to the appointment, and while awaiting the meeting of the council, engaged in conversation with several of the members. Being anxious to ascertain their sentiments, he asked their opinion: one thought it a very fine design; another, that it must cost a great deal of money; but none would venture to pronounce that it was a desirable and executable project. At length the council met, and the most vehement objections were taken to the idea; the principal one being, I believe, to its vast cost. At length the chief minister said, "It is the wish of the Emperor." These words at once calmed the storm, like oil poured upon the waves; not a dissentient was heard; many raised their voices in praise of the noble conception of the Emperor, and the immense talent of the architect; and the requisite millions no longer forming any obstacle, the design was approved, and ordered for execution with the necessary funds.

I do not at the moment call to mind any very large public building that Mons. Visconti has erected at Paris; but the monument of Molière in the Rue Richelieu, the fountain on the site of the old Opera Place Louvois, the noble fountain of the Place S. Sulpice with the sedent statues of the four great Doctors of the Gallican church, a fine façade at the angle of two streets in the Rue Neuve des Petits Champs, and lastly, the tomb of the Emperor Napoleon under the dome of the Invalides, attest the fertile imagination, originality, knowledge and taste of Visconti, and doubtless contributed to indicate to Louis Napoleon one capable of realising the noblest projects in his art.

In October last I experienced many marked attentions from our colleague, due doubtless to the position I hold among you as your Foreign Secretary. He received me at his house, and I must own that his reception rooms displayed refinement and elegance superior to any other private residence in Paris. The furniture was of a superb description, and full-sized chiffonnières of black ebony with glazed fronts contained most exquisite enamels of various sizes, dishes and vases of Raphael and Lucca della Robbia ware, or china of the revival; there were fine bronzes and choice pictures: in fact, one seemed to breathe an atmosphere of art, evidencing the host a man of refined taste, and one who possessed a perfect discriminating relish for all the arts.

He was heir to a great European name, one of a family distinguished for archæological learning, and has nobly maintained the reputation of his ancestors. His personal presence did not seem to indicate the noble qualities within him; but his exalted genius, his simple unaffected manners, his cordial address, his loyal and generous sentiments were the confidence, the esteem and admiration of all who were admitted to his friendship. I need hardly say how highly he valued the gratifying compliment paid him by this

Institute in electing him an Honorary Member. He entrusted me for presentation with a copy of the work shewing his design for the completion of the Louvre, inscribed with his own hand, and, at my request, has sent you full-sized drawings of certain iron girders for the floors, one of 70 ft. span, which he purposed employing. At some future evening, with your permission, I may perhaps give a history of the Louvre and Tuilleries, note the various projects for their union, describe that of our lamented colleague, and explain some points of ingenious construction in the floors.

Last Wednesday, only five days ago, his remains were deposited in Père la Chaise, followed by one of the carriages of the Emperor, and attended by many Ministers of State and noble functionaries, the leading men in science, literature, and the fine arts; his pall borne by the most distinguished men in France, and accompanied by the tears and regrets of several hundred workmen, who felt that they had lost indeed a noble leader. The long line of streets, which led to the cemetery, abounded with testimonies of respect to the memory of this great man. And a Minister of State, the perpetual Secretary of the Academy of Fine Arts, our colleague, Mons. Caristie, Mons. Rohault de Fleury, and Mons. le Baron Paul de Richemont successively addressed the thousands assembled, as did also our Honorary and Corresponding Member, Mons. Hittorff, from whose touching discourse I borrow a few sentences, which seem penetrated with a due appreciation of the character of his colleague and friend.

“The loss” said Mons. Hittorff “of an artist, who united the highest faculties of the mind to the no less noble qualities of the heart, is afflicting to those who were privileged to possess the opportunities of appreciating in him those high natural gifts. But when, as now, this artist is carried off in the midst of the most important works, at the moment when he might naturally look forward, as we all might, to their happy completion and glorious success, this loss is no longer a mere family bereavement, it is a public calamity. Certainly in the immense and grandiose work, which fell to the lot of Visconti, it required, in addition to the conception of the architect, a rare combination of circumstances to carry up, in less than two years, that which had occupied nearly half a century under the greatest of our kings; it required still more to know how, as did our friend, by incessant activity, by a rapid coup d’œil, by a discernment as prompt as just, to render available all those precious elements, and to organize an army, as it were, of able and intelligent assistants and artificers to carry out the work.

“The head of the State was doubtless glad to connect his name with the completion of the finest palace in the world, and perhaps, still more to recall by such a work, minds which had too long been led astray; nor did the architect peril his fair fame in this surprising rapidity of execution, which astonished all Paris, and excited the wonder of those foreigners who flocked hither. Mons. Visconti bestowed the utmost care upon the soundness of the construction, as upon the exquisite beauty of the design. These incessant occupations and flattering combination of circumstances did not at all alter the natural character of our friend. Although naturally aware of his own capacity, surrounded by numerous gifts of fortune, raised to the enviable position of Architect to his Emperor, Member of the Institute of France, President of the Central Society of Architects, nothing altered the constant amenity of his character, he was still the same unaffected modest man, always ready to oblige, and ever disposed to recognise the merit of others.”

To such an eulogium it is unnecessary for me to add one word; but, in conclusion, I beg to notice an inadvertant expression which escaped M. Rohault de Fleury in his address—it is contained in these words, “*it has been said with just reason that the loss of Monsieur Visconti is irreparable.*” To his family and friends such a bereavement is irreparable: but you and I, gentlemen, must feel, that however great this loss may be to architecture, it cannot be irreparable to France, when she possesses so many men of such distinguished talents to uphold the high rank which she has attained in the commonwealth of the arts.

It is my melancholy duty to announce also the death of Mons. Gau, also our Honorary and Corresponding Member, author of the noble work on Nubia, and architect of the new Gothic church, S. Clotilde,

in the Faubourg S. Germain. M. Gau had also erected a very extensive prison at Paris, and had executed various other works of considerable importance. He was a native of Cologne, but had passed his professional life at Paris.

These few notes, hastily put together, may prove to our professional brethren abroad, that we are watching their works, admiring their talents, sharing their sympathies. Let Architecture, at all events, produce harmony and good feeling among all her sons, in whatever country they may be.

The following is an extract from Mons. Hittorff's address, on the 9th of January instant, at the tomb of his countryman and brother architect:—

“ M. Gau naquit avec de rares dispositions pour l'architecture, et après avoir suivi pendant plusieurs années notre école des Beaux-Arts il partit pour Rome en 1817. Il y fit de fortes études, releva et publia les plans du Vatican et mesura les plus intéressans monumens antiques et modernes de l'Italie. Préparé par le célèbre Niebuhr à une exploration de l'Egypte, il exécuta avec une force de caractère inouïe, la périlleuse et difficile entreprise de compléter *à lui seul*, par le recueil des monumens élevés entre la première et la seconde cataracte, l'immortel ouvrage de l'expédition Française sur les bords du Nil. Tout le monde rendit justice à ce beau travail qui porte l'empreinte de la conscience et du talent et qui fixa les opinions des savans sur l'origine et le développement de l'architecture Egyptienne dans la Nubie. N'eût-il publié que cette œuvre, elle suffirait à la gloire de son nom. Mais M. Gau y ajouta un nouveau lustre en complétant et en achevant, avec non moins le talent, le remarquable ouvrage de Mazois sur les Ruines de Pompée, et en se livrant avec un succès mérité à la pratique de son art. Successivement architecte des travaux d'art d'un de nos premiers chemins de fer, de l'administration des hospices, de la Banque de France, de la ville de Paris, partout l'habile artiste sut faire apprécier un grand savoir, mûri par de fortes études, et réuni à une rigide intégrité. Qualités éminentes qui lui valurent de nombreux et importans travaux particuliers. Toutefois, la construction la plus importante qui occupa M. Gau, pendant les dernières vingt années de sa vie, ce fut la conception et l'exécution de la nouvelle église de Sainte Clotilde. . . . Hélas! cette basilique dont l'achèvement dut être le rêve de bonheur de la fin de sa vie, qu'il vit abritée de sa belle couverture en fer, dont les grosses constructions furent achevées sous ses yeux, une cruelle maladie priva son auteur d'y avoir pu mettre les pieds depuis près de deux années! Quelle ne dut pas être la douleur du pauvre artiste lorsque, sans espoir de retrouver la faculté de ses membres paralysés, la pensée de ne jamais contempler accomplie sa belle œuvre, vint l'accabler de sa poignante réalité! ”

DESCRIPTION OF THE FRENCH METHOD OF CONSTRUCTING IRON FLOORS.

Read at the Ordinary General Meeting of the Royal Institute of British Architects, January 9th, 1854.

By H. H. BURNELL, Associate.

IN describing the system of the “Planchers en fer,” or Wrought Iron Floors, it is not my intention to enter into a detailed account of the various experiments made before the systems now so generally used in Paris were brought to their present state of perfection,—to occupy your time with calculations of the resisting powers of rolled iron, or discuss the suitability of the forms adopted; but avoiding all that might tend to embarrass the question, I propose to confine myself to a succinct and simple description of the systems now most frequently executed, and to furnish such practical information as I have obtained by visiting the works where they are employed, and hearing the opinions of the architects conducting them.

It would seem that, for some years past, floors composed of rolled iron joists have been occasionally executed in Paris; in most cases, the joists were flat and without flanges: such constructions were known as the *Système Vaux*. The systems to which I am about to draw attention are little more than an improvement in the form of the joist, and may be said to have come into general use at the commencement of the extensive alterations in the *Rue de Rivoli*, in the spring of the year 1852.

In the various works treating on the subject several systems are described, but upon visiting the Parisian buildings now in progress, we perceive but two: one purporting to be the system of *Mons. Thuasne*, and the other appearing to be that of any one who may get an order to execute it. From the observations made by parties conversant with the matter, I am induced to believe that the different systems are no longer recognised in general practice, and that the architect or builder combines at pleasure the advantages of all.

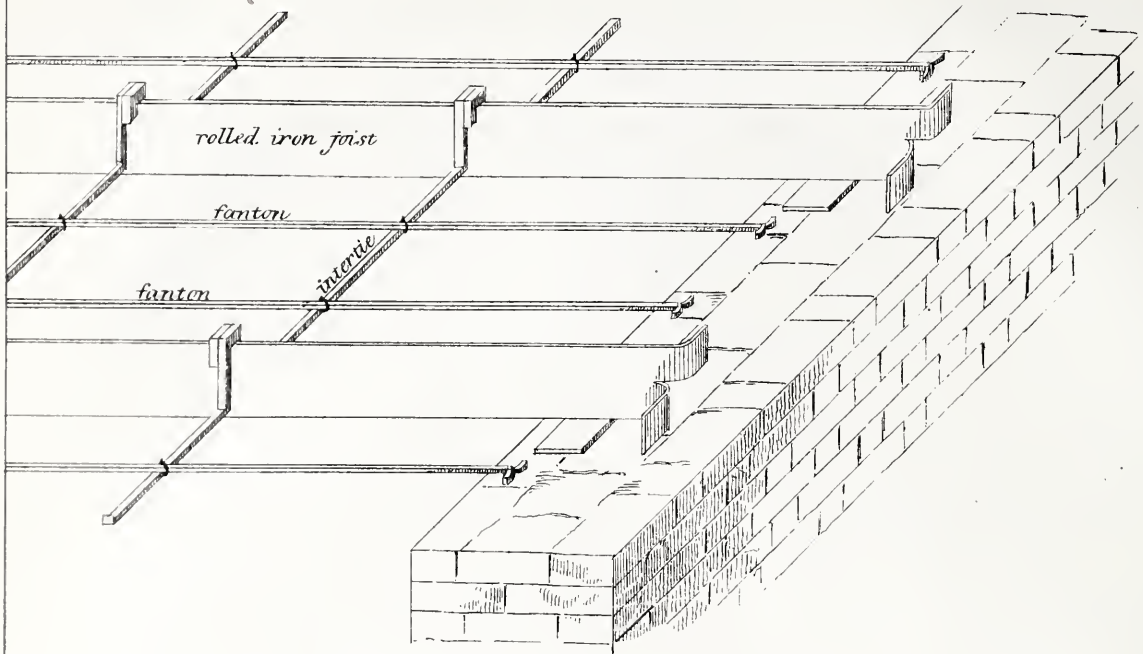
The “*Système Thuasne*” may be described as being composed of joists of iron, rolled in the form of the double T, and slightly arched in the proportion of 0.005 mètre in the mètre, or of 1 in 200. They are placed at the distance of 1.00 mètre (or 3 ft. $3\frac{1}{3}$ in.) from centre to centre, and are united by interties, formed of flat iron bars, fixed at the same distance of one metre apart. These interties rest on the lower flanges of the joists, and are let into wrought iron bands fixed round them; a small pin is then driven through the hole at the extremity of the intertie, between the joist and the band, and the transverse tie is formed.

The fantons are light iron rods, from $\frac{3}{8}$ to $\frac{1}{2}$ in. square, of the same length as the joists, and parallel with them; they are laid on the interties, and bound to them with copper wire, and may be said to take the place of the ceiling laths. Some of the joists and interties next the walls have their ends so formed as to make them act as ties; thus the ends of the system being firmly built into the walls, the sides of the house are effectually united. The iron-work is usually painted, and allowed to dry thoroughly, before it is brought to the place of construction.

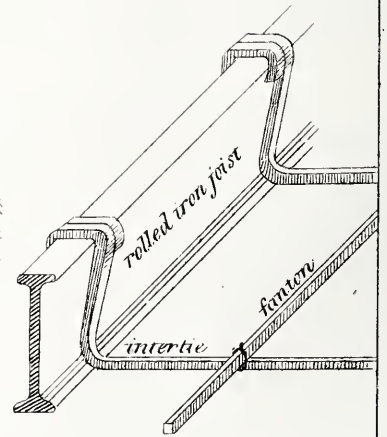
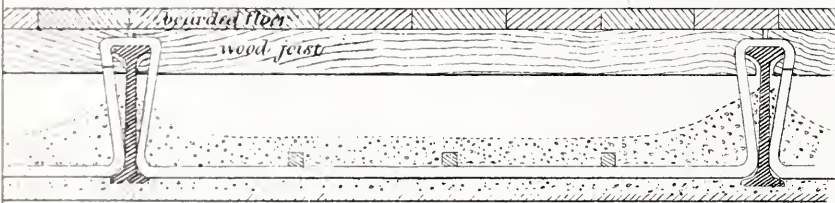
The above-described net-work of iron being completed, the next process is the plastering or grouting. This process differs so materially from the English mode of forming a ceiling, and is so important a part of the scheme, that it requires to be understood before the success of the whole can be comprehended. It is done thus: a board or flat centering is placed under the part intended to be filled in; a grouting composed of the coarsest quality of plaster is then poured in upon it, and running in between the lower portions of the iron-work, it stops against the board beneath, and forms the ceiling of the room below, which one coat of fine plaster serves to finish. The plastering thus applied is from $2\frac{1}{2}$ to 3 inches thick, and sets in about half an hour; it shortly becomes as hard as stone, and assists much to stiffen the floor.

The second system referred to differs in some degree from the first, the joists being placed nearer together, perhaps from 2 ft. 4 in. to 3 ft. apart. The interties are formed of iron bars, from $\frac{5}{8}$ to $\frac{1}{2}$ in. square, bent at the ends so as to clip the upper flange of the joist, and again crooked downwards to rest on the lower one; the elbow so made pressing against the side of the joist, a strut and tie is at once formed

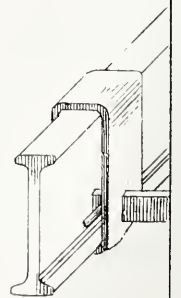
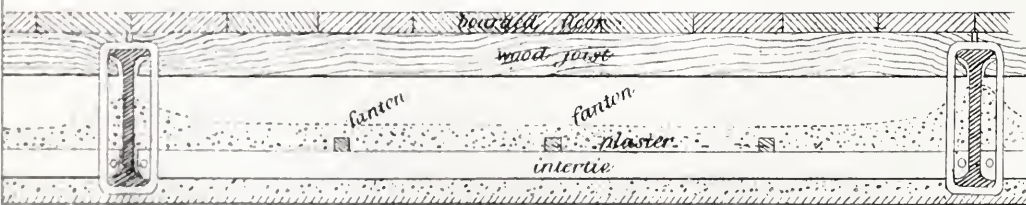
SYSTEM VAUX.



SYSTEM IN GENERAL USE



SYSTEM THUASNE



Scale 1/2 full size

Vincent Brooks Luth King St Covent Garden

between the joists. Interties upon this principle are of course made as nearly as possible of the same size, and when placed between the joists, a blow with the hammer is sufficient to fix them in their position, and make them touch at the required points. They are placed about 3 ft. apart, and as nearly as may be in a direct line, so that one may resist the action of the other. The fantons or light iron rods lying parallel with the joists are laid on the interties, and the grouting performed as in the former method. The floors of the New Louvre are made upon this principle, and filled in with pottery.

It need scarcely be remarked of these rolled iron joists, that they may be made of any intermediate thickness between the stoutest and lightest of the patterns given, the depth of course remaining the same. This offers some advantages, particularly in France, where iron is dear, and the apartments divided into rooms of very different dimensions; as, in many cases, it may be desirable that the floor of the smaller room should be of the same depth as that of the larger one; but the span being less, the lighter description of joist would suffice, the internal walls being assumed to have the necessary strength to take the bearing.

As I have elsewhere observed, the grouting is always more or less of plaster, but in many cases the space between the joists is filled with pottery, that is to say, small cylinders of baked earth, about $7\frac{1}{2}$ in. high and 4 in. in diameter, having the ends closed, and somewhat resembling flower pots; these are bedded in a layer of plaster, poured in between the lower portions of the iron-work, and then receive a grouting to fill in the interstices. Perforated bricks, and pipes like those used to form land drains, are manufactured for the purpose, but are rarely used. Where a wooden floor is required (which is frequently the case) it is nailed to small joists notched in between the iron joists; sometimes, however, where economy of space is less an object, the wood joists are laid across the top of the iron work.

With regard to the relative merits of the two systems, little need be said: that of M. Thuasne binds the joists more effectually at the bottom, where they are best calculated to resist the expansion of the plaster, and it may also be accompanied with some trifling economy of iron, but notwithstanding this, it has the character of being on the whole the dearer, and on this account the other method is more generally adopted. Both offer advantages on the score of being easily fixed, and when executed with common intelligence, answer well, producing a light fire-proof floor in two-thirds of the space of the ordinary wooden construction. It will be seen that floors made upon either of these principles are as incombustible and sound-proof as most others professing to offer the same advantages. It is clear that violent heat, if long continued, would calcine the plaster and ultimately bend the joists; but even in this case, were pottery of any kind judiciously employed, it would offer a serious opposition to the flames, and would be infinitely less dangerous to those in or near the building than cast iron girders or joists with heavy masses depending upon them. I have here, however, alluded to an extreme case, as it is highly improbable that an extensive conflagration should take place where the floors and staircase are of incombustible materials.

It is with some misgiving that I speak concerning the cost, feeling that it is unlikely that a common calculation made from the French tariffs should be found a correct guide to the expense in England, as so much depends on the skill and enterprize of the parties undertaking the manufacture, the effect of competition, and the demand for the material. Perhaps for present purposes it may suffice to consider the probable prices in England to be the same as those of Paris, for it should be remembered that though we have iron in greater abundance, the wages of English exceed those of French workmen. The want of a material like the French plaster will next be felt. I am not aware that we have anything that effectually takes its place at a moderate expense. The price of French plaster in London is 32s. or 33s. per ton, about 30 per cent. dearer than in Paris; but I believe I am correct in saying that this plaster, when fresh, may be mixed with an equal quantity of sand, cinders, or ground brick, and answer the purpose in question. The cost of grouting in England must therefore be considered as double that of Paris.

The accompanying table is translated from a tariff of prices circulated by Mons. Thuasne last year; it also gives the weights and depths of the floors for the various spans.

Bearings.				Depth of Joist.	Depth of Floor complete.	Weight per Square.	Iron Work, per Square.	Including Grouting, (12 Shillings) per Square.
FT.	IN.	FT.	IN.	INCHES.	INCHES.	lbs.	£. s. d.	£. s. d.
From 10	0	to 11	6	4	$7\frac{1}{8}$	370	2 19 5	3 11 5
11	6	— 13	0	$4\frac{3}{4}$	$7\frac{7}{8}$	420	3 6 5	3 18 5
13	0	— 16	6	$5\frac{1}{2}$	$8\frac{5}{8}$	465	3 14 4	4 6 4
16	6	— 20	0	$6\frac{1}{4}$	$9\frac{1}{2}$	510	4 1 9	4 13 9
20	0	— 23	0	$7\frac{1}{8}$	$10\frac{1}{4}$	605	4 17 6	5 9 6
23	0	— 26	0	$8\frac{5}{8}$	$11\frac{3}{4}$	700	5 12 4	6 4 4

I regret that I am not in a position to furnish more ample information on this head, and that I am unable to produce accounts of some experiments which might convey an idea of the resisting powers of the floors when complete, though I know that these experiments have been made; but, perhaps, the general adoption of one or other of the methods may be received as the best guarantee of their results being satisfactory.

In connexion with the subject of the general use of iron in France, much might be said on the French manner of constructing wrought iron girders, but as the most remarkable of these are to be found in the buildings of the new Louvre; and as we have just heard that all matters connected with that important building will be treated at a future meeting by our Honorary Secretary for Foreign Correspondence, I shall abstain from offering any remarks on the subject.

In conclusion, I would add that I have been induced to offer the foregoing remarks, because I conceive that an invention that is well received in a city so important as Paris, must be practically interesting to us, particularly if in our own country the advantage of that invention be partially wanting; it is true that our mode of building and inhabiting our houses differs generally from that of the French capital, where they are usually let in apartments or flats, but in many instances the same arrangements occur here, and in such cases, at least, we might avail ourselves of the experience of our talented neighbours. Many prejudices and conflicting interests must be overcome before any invention can be generally adopted; those of the Parisian building world seemed to have yielded readily to the desire to improve, and the opportunities offered to the development of a new method by the extensive character of their alterations; and though the improvements in our own metropolis proceed with less vigour, we may endeavour to evince as little prejudice as our neighbours in our enquiry into the merits of that principle, which constructively has done its part to invest their newly-erected buildings with stability and refinement worthy of the age.

The CHAIRMAN, Mr. G. GODWIN, Fellow, observed that the questions of weight and expence were among the most important in reference to the construction of iron floors; and it would be desirable to compare the method described by Mr. Burnell with similar plans which had been adopted in England. Mr. Hosking in his book on "Building in Towns," had described a method of flooring used in Paris, and some floors upon a similar principle had, he believed, been constructed at Messrs. Clowes's printing office, and had been found to answer exceedingly well.

Mr. FOWLER, Fellow, inquired what was the effect of weights on the floors described in reference to elasticity. Although doubtless strong, the joists were apparently slight; and he wished to know whether any particular deflection might take place, in the case of persons dancing on such floors.

Mr. BURNELL stated that the *Rèvue Generale de l'Architecture* gave the following experiment made

upon a floor 16 ft. span (systeme Vaux) the joists being $5\frac{1}{4}$ in. deep, $\frac{3}{8}$ in. thick, and cambered 2 in. in the 16 ft. Upon the grouting being filled in the camber was reduced to $1\frac{3}{4}$ in.; upon the floor being loaded with 1,000 lb. per yard super. it was reduced to $1\frac{3}{16}$ in., and after forty-eight hours pressure again decreased to 1 in., the deflection from the load being $\frac{3}{4}$ in.; the weight being removed, the floor resumed a camber of $1\frac{9}{16}$, having lost $\frac{3}{16}$ in the experiment. When filled in with pottery, these floors were lighter, but the filling in with solid plaster formed the whole, in his opinion, into a stronger and more solid mass.

Mr. G. R. BURNELL, C.E. referred to a paper read by himself at the Institute in 1849, in which he had alluded to Vaux's system. Since that time several works had been published on the subject,—the most recent and the best being one by General Morin, who in the fourth volume of his "Cours de Construction" gave an elaborate set of experiments on the resistance of these floors, and the formula on which their thickness and general dimensions might be calculated. From these experiments it appeared that a floor of 26 ft. span shewed a deflection of seven centimetres, with a weight of 70 lb. on the square foot, in addition to the weight of the floor itself. It appeared to him (Mr. G. R. Burnell) that one of the great objections to the modern French system of filling in with plaster, was not so much the weight as the expansive action of the plaster. In practice the effect of this was to bring the floor down nearly half the amount of deflection, produced by the extreme load which the floor would bear. The use of pottery was therefore preferable, and it would be especially so in this country, where plaster of Paris was comparatively expensive. The conflagrations which had lately occurred in the city rendered it important to devise some incombustible flooring; and it was to be much regretted that in England insurance from fire was a tenant's tax, instead of being a landlord's tax, as in France, because there was no inducement to builders and landlords in this country to construct fire-proof houses.

Mr. DONALDSON, Hon. Sec., observed that the rent was regulated in each case with reference to this fact, and THE CHAIRMAN considered that the prevalence of short leases, instead of freeholds, might equally explain it.

Mr. PAPWORTH, Fellow, referred to a house in Hinde Street, Manchester Square, built by Dr. Gillies, the Scottish historian, the roof of which was made of cast iron bars, little more than $4\frac{1}{2}$ inches deep, with a sufficient flange, and filled in with flower pots, precisely as in the French method, but cambered so as to form a vault. This had always stood exceedingly well until the walls began to settle: there was then a fracture which had caused considerable trouble; but that had been remedied, and the roof still stood very well indeed. With respect to the expansion of the plaster, mentioned by Mr. G. R. Burnell, he could not understand why it should press downwards, when there was no abutment above to prevent it expanding in an upward direction.

Mr. FOWLER observed that it had an abutment above; being turned up against the joist, in a form equivalent to a curve; and, therefore, if expansion did take place, it must press downwards.

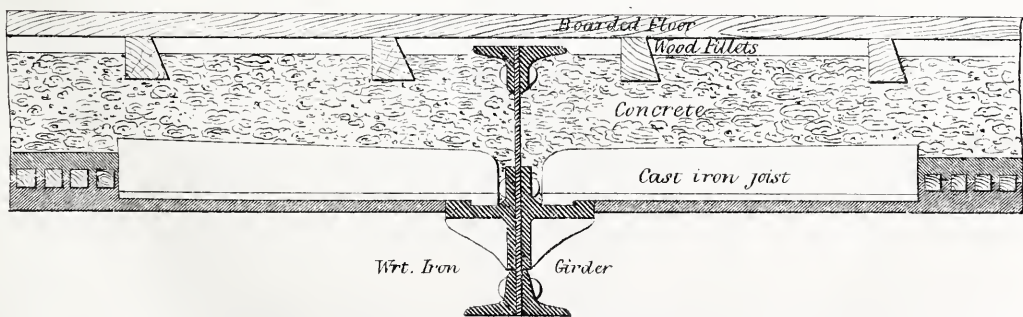
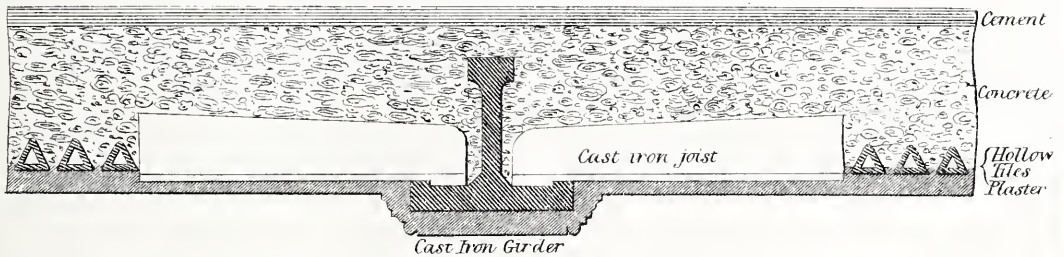
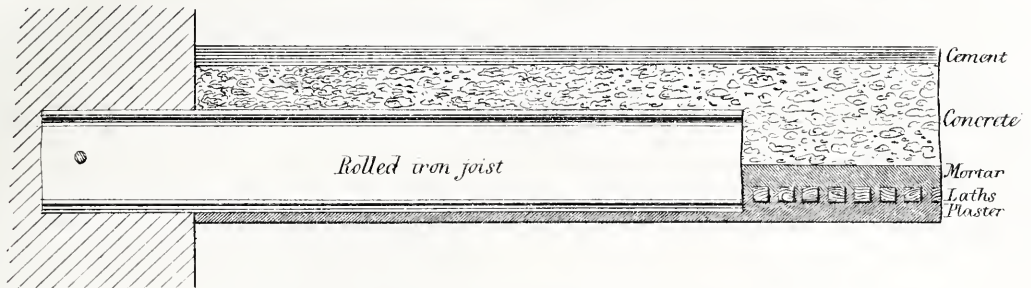
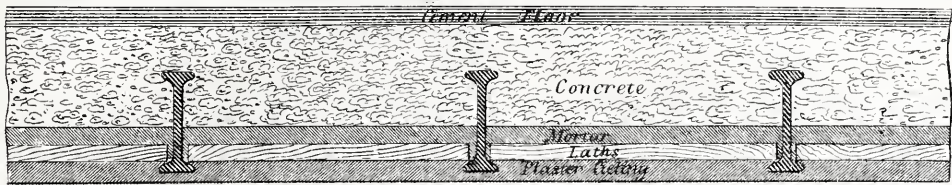
Mr. PIPER, Visitor, stated that the plaster would expand in all directions. The floor at Messrs. Clowes's warehouse, referred to by the Chairman, was of the ordinary construction, with timber joists; but a plaster of Paris ceiling was attached to it, or a sort of flat centering was fixed and secured below the joists, and the plaster was filled in from above the laths; the laths being of oak, and stronger than usual, both in material and scantling, and placed at a wider interval. The plaster therefore passed through and formed the ceiling below, and a sort of pugging above; it consisted of two parts of sand to one of plaster. The floor was constructed of three courses of plain tiles, in order to make it a perfectly fire-proof and air-proof chamber, used as a drying room; no bad effects had arisen from the expansion of the plaster. With reference to the use of cast iron in floors, he had had great experience in those constructed on Fox and Barrett's principle; and it had always occurred to him that cast iron was an unsound material to be subjected to a permanent set, and to be strained as a floor was liable to be; and therefore the introduction of rolled iron joists, which were produced so successfully at the Butterley Works, was a great advantage. Six floors had been constructed with cast iron joists in the Albert Buildings, Spitalfields; and at the top of

the building a defective joist broke, and fell down vertically, striking out one joist in every floor as it fell, without disturbing the rest—an illustration of the extreme brittleness of the material. Regarding the concrete as an addition to the weight, without being any addition to the strength, or having any natural cohesion or connexion with the iron, he had not been prepared to expect a very firm floor as the result of the combination, in a span of eighteen to twenty feet, in a coach manufactory in Regent Street; but on the contrary, he was surprised to find that, when the mass became set, it was rigid to an extraordinary extent, forming a kind of uniform landing, in which there was a good brotherhood between the concrete and the iron, the whole forming a trustworthy mass. With regard to the cost, his experience had shewn him that in Messrs. Fox and Barrett's construction it was equal to that of an ordinary floor, with the addition of the price of the floor boards; but the present state of the iron market would somewhat interfere with that calculation. From the actual rigidity to which he had referred, he was disposed to think the French floors described would have a great amount of strength. Alluding generally to the facilities for the spread of fire in houses, by means of skirtings, staircases, quarter partitions and roofs, as at present constructed, he illustrated the power of an ordinary plaster ceiling to resist the action of fire, by referring to a severe fire on his own premises, which began in the shop, and spreading upwards by the staircase ignited the roof, and then burnt downwards. The first floor was however left entirely perfect, and the second nearly so; the only obstacle to the fire reaching them being the plaster ceiling of the ground floor, where the fire commenced.

MR. BARRETT, Visitor, said that, from the remarks made this evening, he was more convinced than ever that the use of iron in the construction of floors was only a question of time. With regard to these French floors, their liability to deflection was a radical defect, as no finished floor ought to be liable to the slightest deflection or want of rigidity. The system described could moreover prevail only where plaster was abundant—as in Derbyshire, Leicestershire, Nottinghamshire. Objections were also raised to plaster on the ground of its imparting a disagreeable smell, and of its tendency to swell. He had adopted rolled iron in his own method in consequence of the prejudice against cast iron joists, and he proceeded upon this safe principle: that, taking the concrete as so much dead weight, his joists were so proportioned that that dead weight, together with the extreme load which could subsequently come upon the floor, should not exceed the elastic limit of the iron. He used rolled iron joists for spaces not exceeding 24 feet. On reference to the table of weights used in Paris, he found that the French floors had not more than half the strength of his own; thus, with a bearing of from 16 feet 6 to 20 feet, the French used a weight of iron of 510 lbs. per square, whereas he should use 8 cwt., in addition to the difference in the weight of the grouting; and therefore, if the French floors were safe with 5 cwt. of iron, his floors must be more than safe with 8 cwt.; and the cost of the latter, in joists only 18 inches to 2 feet apart, as compared with a timber floor, was about 7 to 10 per cent. additional. The thickness of concrete, on his plan, in a floor of 20 feet span, would be 7 inches from the flange of the joint, the whole substance being 12 inches thick, including 2 inches for the floor itself; and as a question of expense, it would be very easy to reduce the strength of the iron (and with perfect safety), so as to bring down the cost to that of an ordinary timber pugged floor.

THE CHAIRMAN, observing that it was impossible to overrate the importance of the subject, suggested an adjournment of the discussion, in order to elicit the careful and deliberate opinions of the members, rather than their hasty and unconsidered observations.

MR. C. H. SMITH, Visitor, stated, for the consideration of the Members, the fact that no material could be more destructive to iron, especially wrought iron, than plaster of Paris. The girders might be coated with some material to protect them, but in moving them about it was liable to be chipped off; and if the smallest pinhole were exposed to the plaster of Paris, the iron would be corroded. On the contrary, lime tended to preserve iron; and therefore a coating of $2\frac{1}{2}$ inches of ordinary mortar next to the girders, before using the plaster of Paris, might be desirable. The Meeting then adjourned.



Scale One Inch to a Foot.

Vincent Brooks Lith. King St. Covent Garden

ON THE FRENCH METHOD OF CONSTRUCTING IRON FLOORS.

Being a Discussion (in continuation of that which took place at the previous Meeting) held at the Ordinary General Meeting of the Royal Institute of British Architects, January 23rd, 1854.

MR. BARRETT, Assoc: Inst: C.E., requested permission to read a Paper containing some further explanation of the system of fire-proof construction with which he was connected, and which was known as "Fox and Barrett's patent."

The objects accomplished by this system, whether applied to Public Buildings, Dwelling Houses, Warehouses, Mills, or other structures, are as follows:—

To make each floor, as well as the roof of the building, fire-proof, so that fire can neither be communicated from one story to another, nor be introduced into the building by burning away the roof:—

To avoid all lateral thrust, or weakening effect, upon the walls; and to distribute the weight over them, instead of concentrating it on certain points:—

To secure the building from the attacks of dry-rot:—

To give increased solidity, firmness, and durability to the structure:—

To render the floors practically sound-proof, when finished with a boarded surface:—

And to combine these advantages with great simplicity and economy of construction, and a much less thickness of floor than is usually required.

These objects are accomplished by forming the floors of the buildings of materials as imperishable as the walls themselves, the leading features of the system being, the substitution of girders and joists, either of wrought or cast iron, for those of timber, and the employment of layers of incombustible materials, supported by, and consolidated with the joists; the whole, when combined, forming a solid fire-proof foundation, adapted to receive a finished surface, either of cement, asphalte, tile, slate, stone, or other material; or upon which foundation the ordinary boarded surface, upon light sleepers, or bevelled fillets, may be laid down.

The principle of construction, as applied in its most simple form, is shown in drawing No. 1.* The joists are fixed as the building proceeds, the ends being firmly built into the walls; and the floor is afterwards formed by light strips of wood, being first laid across from joist to joist, bearing on the bottom flange, and having narrow spaces between them. Upon these is spread a layer of coarse mortar, which is pressed down between the strips, so as to form, with them, a rough and uneven surface for the pricking-up coat of the ceiling; the subsequent application of which thoroughly imbeds the strips in mortar. A layer of concrete is then applied, of the requisite thickness to ensure the necessary rigidity in the floors. This thickness is determined by the nature of the building, the width of bearing, and the required degree of strength. The ceiling is applied of such a thickness as to perfectly imbed the flanges of the joists, and thus protect them from the action of fire from below. A fire-proof foundation is thus formed, which, when thoroughly consolidated by the perfect setting of the concrete, is of great strength and rigidity; while the pressure upon the walls is *strictly vertical*. The finished surface of the floor is applied when the concrete is set and dry.

The joists are made of a form combining strength, lightness, and economy; their section depends upon the nature and uses of the building to which they are to be applied, and in all cases they are proved, before

* The drawings referred to were exhibited at the Meeting, but cannot be published with the present Report.

they are fixed, to an extent more than equal to the greatest load that can ever be brought upon them, care being taken that this proof is within one-third of the breaking weight in the use of cast iron, and within the elastic limit of the material in the use of wrought iron. This precaution may perhaps be considered unnecessary with the latter material, more especially as the mode of construction is one which, in effect, ties the whole of the ironwork together. It is, however, more satisfactory to prove the joists, and it is done with a lever at the most trifling cost.

The strips, which answer the double purpose of a foundation for the concrete, and a key for the ceiling, may be made of any non-combustible material instead of wood; but it will be seen that these strips are so placed that their ignition is impossible, as they are completely imbedded in the mortar, and have a superincumbent mass of concrete, which prevents the establishment of any current of air, and renders them practically proof against fire. This has been proved on several occasions. Amongst other materials that can be substituted for these wood strips, small draining pipes may be mentioned, and if made of a triangular form, they give an excellent key for the ceiling.

The concrete is formed of the materials most readily obtained in the locality of the building, such as fine gravel or ballast, burnt clay, or broken brick, mixed with a proper proportion of good stone lime, the whole being laid on moist and well trodden in.

For the finished surface of floor, besides the ordinary flooring boards, cements of different kinds, such as Portland, Keene's, and Parian, may be used. Asphalte, metallic lava, slates, and tiles, in cement, have also been employed as a finished surface, both for floors and roofs.

In applying this system to dwelling houses and similar buildings, the joists are first tested singly to bear weights equal to from 120 to 150 lbs. per square foot of floor; that test being in the case of the employment of cast iron, one-third of the breaking weight, and in the case of wrought or rolled iron, the elastic limit of the metal. For buildings of a different character, and requiring stronger floors, the strength and the test are increased so as to meet the requirements of the structure. The joists are then fixed on the walls, and when built upon, they form a series of ties which greatly strengthen the building. A considerable accession of strength is given to the joists by their ends being thus firmly fixed in the walls, and every successive step in the process of construction tends both to develop additional strength, and also to protect the joists from the effect of impact or concussion. The strips or pipes are the groundwork of a continuous strut, which is completed by the subsequent application of the mortar and concrete, the latter completely imbedding the whole of the ironwork, which is pressed equally on both sides, and the concrete well trodden under the upper flanges of the joists. Thus it will be seen that the force of compression acts upon the joists only through the medium of the concrete. What the actual addition is to the original strength of the joists, by in the first place firmly fixing the ends, and then by the perfect union and combination obtained in the process of construction, has not been ascertained; but an idea of the enormous weight that would be required to break down a floor may be thus obtained:—Supposing the room to be 18 feet square, thus containing 324 square feet in area; the joists, having an original working strength of 120 to 150 lbs. per foot, the *average ultimate* strength is 405 lbs. per foot, and if it is assumed that an increase of 25 per cent. only, is obtained by the fixing, and the consolidation of the entire mass, the breaking weight is 500 lbs. per square foot, which, multiplied by the number of feet, 324, gives 1446 *cwt.*, or upwards of 72 *tons*, as the load required to break down the floor of a room 18 feet square; and this it should be remembered is not a floor in which extra strength is provided, but merely the room of an ordinary dwelling house, which, if packed with 200 people, or as full as the "Black Hole" at Calcutta, would only be loaded with 15 *tons*, or about one-fifth of the breaking weight of the floor. In assuming 25 per cent. as the gain in strength, a low estimate is taken, for an increase of twice this, or 50 per cent. is commonly reckoned as due to the firmly fixing of a beam alone; while the great principle of this system is

the gradual developement of strength and firmness; the effect of the load being transferred, through the medium of the concrete, to the walls, or other vertical supports; the entire floor becoming in effect, *one large beam with iron ribs*. This calculation has reference to the use of joists of cast iron; with joists of wrought or rolled iron, the ultimate strength would be considerably greater.

There is of course a limit to which single joists can be carried on this system, but as rooms 24 feet in width have been constructed with them, and without the use of main girders, it is very rarely that the latter are required for dwelling houses and buildings of the same class. When, however, the span much exceeds 20 feet, the adoption of girders, with minor joists bearing upon their flanges, is the most economical method. In this way floors of 60 feet span have been constructed, the girders having an intermediate bearing on columns placed 20 feet apart. Floors of 30, 36, and 42 feet span have also been constructed with girders and joists, without the aid of columns.

It may be said, therefore, that there is scarcely a limit to the application of the system as regards the space to be covered, while there is probably no kind of building to which it is not capable of being adapted. Besides public buildings of different kinds, such as hospitals, lunatic asylums, and workhouses; buildings for records, railway offices, banks, hotels, exhibition rooms, baths and wash-houses, training institutions and schools, &c., the system has been extensively adopted in private buildings, such as mansions and dwelling houses, offices and chambers, and dwellings for the working classes. It has also been employed in the construction of warehouses and mills.

This system of construction is not therefore to be regarded as a mere theory, but as one which has been very extensively applied, and has moreover stood the test of an experience of twenty years: I mention this first to disclaim all merit whatever in having originated it. It is to a member of the medical profession, recently deceased, Dr. Henry Hawes Fox, that we owe the introduction of this principle of construction. That gentleman erected in the years 1833-34 an extensive private lunatic asylum in Gloucestershire, and built it entirely upon this principle, and ten years afterwards, in the year 1844, at the urgent solicitation of his friends, and as the only means of bringing a valuable invention, which had on several occasions saved the building from destruction by fire, into general use, he was induced to patent it. My own connexion with it dates from the year 1848, since which period it has, as I have said, been applied successfully to almost every description of building. Another reason for my mentioning the early employment of this mode of construction, and the date and object of its being patented in England, is, that it has struck me that some persons may possibly imagine that the principle may have been borrowed from the French system, described in Mr. Burnell's paper. Nothing could be more erroneous than such a supposition; a comparison of dates indeed at once sets this question at rest, the patent having been taken out in 1844, ten years after its successful employment by the patentee, while, as I gather from Mr. Burnell's paper, the employment of the French system is comparatively of recent date.

In 1850 I visited Paris myself, with letters of introduction to various architects, only one of whom referred to the use of iron there. He told me that a building was then in course of erection, and recommended me to see it, which I did: it was the Hospice de la Republique, near the Northern Railway Station. The floors were formed by means of girders of wrought iron, consisting of two rectangular bars, the lower one straight, and the upper one arched or curved, both placed on edge, and the two occasionally tied together by vertical straps. These were placed about 5 ft. apart; cross bars 4 ft. apart were carried at right angles with the girders, and three smaller flat bars on edge ran between each girder: spaces of about 4 ft. $\times$ 15 in. were thus formed, and these spaces were filled in with pottery, slightly wedge-shaped, imbedded in plaster; dwarf walls were built on the top of the pots to receive timber joists, upon which the floor boards were laid. The whole appeared to be a very expensive mode of construction, occupying a depth of about 18 in. for a span of $3\frac{1}{2}$ metres or 11 ft. 6 in. This was the only instance I heard of, at a

period six years subsequent to the date of the patent. But independently of priority of date, it will be seen on close examination that the two systems differ both structurally and economically, the only point of resemblance being the form of the joists, which are alike, except that the French joist is made to taper towards the centre, or neutral axis. The peculiar form of intertie adopted in Paris is available where plaster is abundant, the chemical constituents of this material enabling it to set so rapidly, that a considerable open space can be filled in without any intervening support. These interties however are necessarily much more expensive than the strips upon which the concrete is laid, in my system, and which are the mere refuse of a builder's yard. The material used for filling in is different, both as regards its thickness, its tendency to expand, its possible effect on the iron, and the strong affinity of gypsum for ammonia; and the final results of the two modes of construction are different,—the one producing a finished floor, admitted to be subject to deflection, with an ordinary load, and the other producing a floor of very great rigidity.

In illustration of the method of applying this system in cases of extended bearings, where the use of girders is necessary, the drawings Nos. 2 and 3 and from 7 to 11 are exhibited. No. 2 is a section illustrating the application of the system with both girders and joists of cast iron, and shews the method of construction employed at a large flax mill at Newry, the plan of one floor of which is given in No. 3, an Ironmongery Warehouse at Bristol, St. Mark's College, Chelsea, the Metropolitan Convalescent Asylum, and various other public and private buildings. The girders, a section of which is shewn, bear either upon columns or walls, and the joists, which are shewn in elevation, run at right angles to the girders, and are cast with a shoulder to drop over the flange of the girder, and form a tie. The depth of the girders is of course in all cases adapted to the span, and when this depth is greater than the thickness of the floor, an intermediate flange, supported by side feathers, is cast upon the girder. The projection below the ceiling line should be covered either with plaster or fire-proof cement, and take the form of a moulded beam, as shewn in the figure, drawing No. 2. The thickness of the floor in this construction rarely exceeds 10 or 12 in., and the saving of space as compared with the iron girder and brick arch system, will be understood from the fact that a depth of 20 in. is required at the springing line of the arches. This difference, in a mill or warehouse several stories in height, will either economize 3 or 4 ft. of walling all round the building, or give an increased height in the different floors. Drawing No. 7 shews the combination of wrought iron boiler plate girders and cast iron joists, as adopted at the recently erected extensive additions to Guy's Hospital, where the rooms are from 21 ft. to 30 ft. wide. The main girders have cast brackets riveted to the web to receive the joists, which are of cast iron with shouldered ends, to drop into the brackets: considerably more than an acre of floor has already been so constructed in this building. Drawing No. 8 shews the application of wrought iron exclusively; both girders and joists being of this material. The girders, which are also of boiler plate, have an additional or intermediate flange of angle iron, to give the requisite bearing for the joists; which latter are of rolled iron, and are occasionally tied to the girders by small angle plates, bolted or riveted on. This application of the principle has been adopted in various public buildings, (amongst which may be mentioned, the Foundling and Brompton Hospitals, the New Offices of the London and Brighton and the Bristol and Exeter Railway Companies, Her Majesty's New Highland Residence, Balmoral, &c.), 42 ft. being the extreme width of bearing to which it has been at present carried; but there is no difficulty in extending it much beyond this, as the adaptation of boiler plate girders to this system of construction, combined with joists of rolled iron, provides for every possible contingency, whether as regards width of bearing, strength of floors, or liability to impact, or vibration. In cases, however, where the use of columns can be admitted to shorten the bearings to 9 or 10 ft., the same advantages may be secured by the adoption of rolled iron, for both girders and joists; thus avoiding the use of riveted plate and angle iron girders, the labor on which necessarily makes them

somewhat expensive. Diagrams illustrating this double application of rolled iron are shewn, drawing No. 9 being the plan of a floor 63×28 ft., with a row of cast iron columns running down the centre: these columns support a line of rolled iron girders, which pass through a hole left in the top of the column, as in drawings Nos. 10 and 11. The joists are carried over the backs of the girders, and are rolled of a length to span the full width of the building, including the bearing on each of the side walls. The advantage of having the joists rolled in long lengths, and fixed with an intermediate support on the main girders, is a most important one, not only as affording an efficient tie to the building, but as greatly increasing the strength of the floor; this is an advantage which is peculiar to the use of wrought iron. The ends of the joists may be either pierced and secured to the walls by a rod or S piece, or they may be bolted to a plate of iron built into the wall. The extreme ends of the girders being also secured to the walls, a tie in each direction is given, and the whole forms a framework of wrought iron, possessing immense strength, each part affording efficient aid to the rest. In buildings of greater width, the addition of another line of columns would enable the same arrangement to be adopted; the joists being in that case rolled in long and short lengths, placed alternately so as to break joint, and bolted or riveted together at the points where they take a bearing on the girders.

I have already remarked, at the former Meeting, that from prejudice against cast iron joists, though they have been very extensively and successfully used, I was induced three or four years ago to turn my attention to wrought iron. But here I had to break entirely new ground, to institute experiments, and to overcome many obstacles from the manufacturers. The main question was as to sufficiency of strength in a section of a form best adapted for the purpose—the **I** shape—but for the manufacture of which no rolls were in existence. Experiments were therefore tried on **I** shaped bars, and a formula deduced from these, and acted upon by my having rolls prepared from 4 to 8 inches deep of the **I** section. Subsequent experiments on these had fully verified the correctness of the formula, but I had not carried my experiments more than 60 per cent. beyond the limit of elasticity, this amount of strain producing a permanent set of only $\frac{3}{40}$ of an inch. I had heard that iron joists were coming into use in France, but knew nothing of the strength they employed, and have never seen either the joists or floors to this day. I have however recently obtained some information as to the strength considered sufficient in Paris: a friend who is about to build there had sent me some particulars obtained from the engineer of the company manufacturing the joists, and a printed statement of experiments on their strength. This information and these experiments are important as bearing on the question of cost, to which I will almost immediately refer. It seems that under no circumstances, and except in a very extraordinary case, would they place the joists less than from 70 to 80 centimètres apart; and for a floor of 6 mètres, joists 12 centimètres deep, and weighing 14 or 15 kilogrammes per mètre, would be used.

I think the first point to establish is the sufficiency, or rather the actual strength, of the joists, of the scantling used in Paris, and the table of experiments enables us to examine this:—

Joists of 12 centimètres deep, and weighing 15 kilogrammes per mètre, were proved at bearings of 4, 6, 8 and 10 mètres. Converting these into English dimensions, we have for the bearing of 6 mètres, 19 ft. $8\frac{1}{4}$ in.; for the depth of the joist, $4\frac{3}{4}$ in.; for the weight per ft. run, 10 lb; and for the mean distance apart, 75 centimètres, or 30 in. From the table I find that a joist of these dimensions was proved at 6 mètres bearing with 2000 kilogrammes on centre, which is equal to 4000 distributed, or 8800 lb. English. The area of floor this joist would carry is—

$$19 \text{ ft. } 8 \text{ in. } \times 2 \text{ ft. } 6 \text{ in.} = 49 \text{ ft. } 2 \text{ in. and } 8800 \text{ lb. } \div 49 \text{ ft. } 2 \text{ in.} = 179 \text{ lb. per foot super.}$$

But a similar joist was proved with the same weight at 8 mètres bearing, which is equal to 5333 kilog. at 6 mètres:

$$5333 \text{ kilog.} = 11730 \text{ lb. English } \div 49 \text{ ft. } 2 \text{ in.} = 240 \text{ lb. per foot super.}$$

But even this did not reach its limit of ultimate strength, for the joist was further tested at 10 mètres bearing, until the deflection was increased to the extent of just 50 per cent. beyond the last load. It may therefore be safely assumed, that a load of 300 lb. per square foot of floor, would not have broken the joist.

None of the joists I use have been tested to anything like this extent, for as I have said, I have proceeded upon the principle that the joists should not be loaded beyond their elastic limit. We however easily arrive at the strength of such a joist as I have been referring to (for the purposes of comparison) by adopting the simple and universally received formula, that the strength is as the depth² × thickness, and I will reduce both this joist and the one I have used (and which forms the basis of my calculations of comparative cost with a timber floor) to rectangular bars, and compare them:

Taking first the French joist—a weight of 10 lb. per ft. gives a sectional area of just 3 square in.; and a rectangular bar of this area and $4\frac{3}{4}$ in. deep, would give the following result:—

$$15 \text{ kilogrammes per m\`etre} = 10 \text{ lb. per ft.} = 3 \text{ sq. in.} = 4.75^2 \times .63 = 14.214$$

$$\text{while the English joist} = 16 \text{ lb.} \quad ,, = 4.8 \quad ,, = 7^2 \times .686 = 33.614$$

And further,—

$$14.214 \div \overline{19.8'' \times 30''} = .289 \text{ per square foot,}$$

$$\text{and } 33.614 \div \overline{20.0'' \times 24''} = .840 \quad ,,$$

Giving the result of a comparison of strength just 1 to 3; while a comparison of weight would stand thus:

Each French joist carries $19.8'' \times 30'' = 49.2''$ and weighs 220 lbs. = 450 lb. per square.

Each English joist ,, $20.0'' \times 24'' = 40.0''$,, 352 lbs. = 880 ,,

Very nearly as 1 to 2.

Now the conclusion seems unavoidable, that if, as I have demonstrated, the breaking load of the French scantling of joist is equal to 300 lb. per square foot, it is in my case equal to 900 lb. per square foot; but even this is assuming that no strength whatever is derived from the principle of construction, while I believe that with properly constructed floors, that is, with good concrete of the proper thickness, these results, satisfactory as they are, may be increased by at least 50 per cent.

Turning now to the question of cost, the following statement has been prepared of the approximate comparative cost of a floor for a room 12 ft. square, and for one 20 ft. square, constructed on the fire-proof principle, and with timber. The results are as follows:

	Room 12':0" × 12':0"			Room 20':0" × 20':0"		
	£.	s.	d.	£.	s.	d.
Fire-proof floor, formed with strong joists of rolled iron, and a cement surface	7	14	10	32	4	3
Deduct excess of iron in joists to reduce them to the strength of the French scantling	1	17	10	10	12	1
Cost of fire-proof floor.....	5	17	0	21	12	2
Add difference of cost between 1 in. flooring boards and a cement surface 25s. per square	1	16	0	5	0	0
Cost of fire-proof floor with boarded surface.....	7	13	0	26	12	2
Cost of timber floor pugged	8	15	4	31	12	3

These calculations are made with the price of iron nearly 50 per cent. above that of eighteen months ago, and much dearer than for many years past.

The details of these calculations are given below:—

Room 12' : 0" × 12' : 0".

Fire-proof floor formed with strong joists of rolled iron and cement surface:—

Five rolled joists, 13' 3" long, 8½ lbs. per foot—113 lb. each—5 cwt. 5 lbs. @ 15s.	3 15 8
Concrete, &c., ceiling and cement surface of floor, 55s. per square	3 19 2

£7 14 10

Deduct excess of iron in joists to reduce them to the strength of the French scantlings, £ 3. 15s. 8d. ÷ 2	1 17 10
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Cost of fire-proof floor	5 17 0
Add difference of cost between 1 inch flooring boards and a cement surface, 25s. per square	1 16 0

Cost of fire-proof floor with boarded surface ... £7 13 0

Timber Floor—

11 joists, 13' 6" long, 9" × 2" = 18½ cubic feet @ 3s.	2 15 6
Wall plates, 24 ft. run, 4½" × 3" = 2½ " ..	0 6 9
Herring bone strutting, 3s. per square ..	0 4 6
Half brick trimmer and centering, 4' 0" × 2' 0"	0 8 0
144 ft. sup. 1 in. flooring boards, @ 35s. per square	2 10 5
16 yards lath and plaster ceiling, @ 1s. 4d. ..	1 1 4
144 ft. sup. fillets, sound boarding and pugging, @ 20s. per square	1 8 10

Cost of timber floor, pugged..... £8 15 4

Room 20' : 0" × 20' : 0".

Fire-proof floor formed with strong joists of rolled iron and cement surface:—

Nine rolled joists, 22' 0" long, 16 lbs. per foot—352 lbs. each—28 cwt. 1 qr. 4 lbs. @ 15s.....	21 4 3
Concrete, &c.—ceiling and cement surface of floor, 55s. per square	11 0 0

£32 4 3

Deduct excess of iron in joists to reduce them to the strength of the French scantlings, £ 21. 4s. 3d. ÷ 2.....	10 12 1
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Cost of fire-proof floor	21 12 2
Add difference of cost between 1 inch flooring boards and a cement surface, 25s. per square	5 0 0

Cost of fire-proof floor with boarded surface ... £26 12 2

Timber Floor and Ceiling of a substantial kind—

17 joists, 22' 0" long, 12" × 2¾" = 85¾ ft. cube, @ 3s.....	12 17 3
Wall plates, 40 ft. run, 4½" × 3" = 3¾ " ..	0 11 3
2 wrought iron ties, ¾" diam. with screws, &c., 40 ft. @ 7½d.	1 5 0
Herring bone strutting, 3s. per square ...	0 12 0
Half brick trimmer and centering, 6' 0" × 2' 0" @ 1s.	0 12 0
4 squares 1½" battens, @ 42s. per square.	8 8 0
44½ yds. lath and plaster ceiling, @ 1s. 6d.	3 6 9
4 squares fillets, sound boarding and pugging, @ 20s.	4 0 0

Cost of timber floor, pugged..... £31 12 3

Mr. BARRETT stated, in reference to the practicability of reducing the scantlings of the joists on his principle, that although it might not be desirable to reduce them to the French standard, he had no doubt rolled iron joists of an intermediate strength between those used in Paris and his own, might be employed with safety, and thus bring down the cost of a fire-proof floor with a boarded surface to that of an ordinary pugged timber floor. M. Thomas, an eminent Parisian builder, had adopted Fox and Barrett's principle in several houses in Paris, using joists of the strength generally employed there, and he had found the floors superior to the French system, which was defective from its want of rigidity, and from allowing the transmission of sound when the hollow pots were used in combination with the plaster. Mr. Barrett concluded by observing, that it might be considered that he had a personal interest in advocating the English system. Undoubtedly as the proprietor of the patent, to a certain extent he had; but his interest in the patent was for a very limited period,—a period which would be totally inadequate to repay even one-half of the very large sum which had been sunk in establishing it. Independently of personal considerations however, the subject was one of general interest; and as the losses by fire in this country were reckoned by millions of pounds annually, he might say it was one of national interest. Certainly, the general introduction of a system which must promote the use of iron (a material for the production of which our resources were unlimited, and in the manufacture of which native skill only was employed) should be encouraged in every possible way.

THE CHAIRMAN, Mr. MOCATTA, V.P. said, that as architects they must feel the importance and advantage of an incombustible and imperishable floor. With reference to cost, it appeared desirable to ascertain the degree of lightness which would be free from vibration and deflection, in order to avoid a very expensive

mode of construction. Mr. Barrett's system was, he believed, the development of that executed some years ago in Gloucestershire by Dr. Fox, which excited much interest at the time. With respect to one matter of detail in Mr. Barrett's system,—namely, the small laths placed between the joists to receive the concrete, he inquired whether those laths were not very slight to carry so great a weight, as if they were liable to become bent, the consequence would probably be a cracked ceiling.

Mr. BARRETT stated that these laths were merely used as a support to the concrete, till it became set. They were 1 in. square by 24 in. long, between the bearings on the iron joists; the weight upon them being only $\frac{1}{16}$ th of their breaking weight. As the concrete became set, the structure became wholly independent of these strips, and if it were practicable to remove them, the structure would for any purposes of strength be complete without them. He had constructed many acres of flooring in this way, and not the slightest difficulty had arisen from the cause suggested.

Mr. TITE, Fellow, said, it appeared to him that the present question was a little involved in a discussion raised some time ago by the late Professor Cowper, who had brought before the Institute the wonderful merits of construction adopted in the Crystal Palace, and told them that they were behind hand in all inventions, and had to learn everything from the Engineers, especially the use of iron. Now he, Mr. Tite, freely admitted the ingenious application of familiar principles which the French system of flooring displayed; but the question of cost, referred to by the Chairman, was probably the main reason why iron joists of this character had not been more extensively used. Architects had certainly been taught by the Engineers to be more extravagant than they used to be, but to an architect the question of cost must be one of the gravest consideration. It was true that in Paris they had seen a great deal of the application of wrought iron joists by Visconti and others, but he felt bound to claim a perfect acquaintance with this matter in his own experience of some twenty-eight years. There was, in fact, nothing new in the principle, either as respected the iron or the concrete. Mr. Tite then adverted to the early methods of forming floors: first by a row of beams placed side by side, the least dimensions downwards, and of an uniform substance, and afterwards by means of strong heavy girders or bearing beams of oak, producing the greatest possible rigidity. This system, introduced in Italy, was adopted by Sir C. Wren, and when (after the fire of London) oak became scarce, fir was used in the same way. This however, being more elastic, was found to bend, and a system of trussing girders by the insertion of iron was adopted, and gradually carried to a great extent. (Mr. Tite described, and illustrated by sketching, several of the varieties of trussed girders formerly in use). Sir Robert (then Mr.) Smirke at length introduced the cast iron girder, and the use of concrete (the latter in the foundations of the Penitentiary, which had failed). Feeling the defects of the old systems of flooring, and believing that they might be remedied by the employment of cast iron girders, Sir R. Smirke, after consulting Mr. John Rennie, introduced the use of them, and had told him (Mr. Tite) that the first he used was of the extraordinary length of 34 feet, without a support between the walls. The next step was made by Mr. Farrell, a smith, who was employed under Sir R. Smirke at the Custom House, and he, regarding cast iron as a very brittle and dangerous material, proposed the use of wrought iron, for which he took out a patent; and between that system of Mr. Farrell's, and the systems now under discussion, there was in fact no difference whatever, except in the ingenuity of the means which had brought to bear upon the latter. In France earthen pots or plaster were used with iron rods between the joists, in England concrete and wooden laths; but these were merely improvements on the patent of Mr. Farrell, who suggested that the space between the joists might be filled in with any fire-proof material. The joist adopted by him was of this form , and as he could not get rolled iron, he rivetted the parts together. Mr. Tite stated, that he had used the system described, many years ago in a large public school, where a cheap fire-proof floor was required, with complete success, and when he last saw this construction it was as perfect as when first erected. The space between the joists was in this case about

4 ft. and filled in with 4 in. and 6 in. Yorkshire landing, which gave a good upper as well as under surface, the interstices being filled with Roman cement, and the ceiling formed of the same material. This was applied to a space of 300 feet long, and on an average 15 feet wide. Important as this subject was, Mr. Tite proceeded to express his opinion that, the systems of flooring referred to, were not applicable to architecture in its more important forms. They might do for a range of offices, an hospital, or any building where plain ceilings were sufficient; but the architect had to consider decoration, and must apply his means accordingly; and it would often happen that the ordinary mode of construction introduced by Sir R. Smirke, with subsequent improvements, was better adapted to such purposes, than novelties of more recent invention. With regard to fire-proofing, the world was not satisfied with actual safety, but required that no part of a building should be combustible, even if no danger could arise from its becoming ignited. Thus, at the Royal Exchange, where he had employed cast iron girders, with arches in cement, the improper substitution of a new stove for the one fixed by his directions, had caused fire to communicate to the frame of a blank window. This frame however might have been entirely consumed without the slightest injury to the building, but the public was not satisfied: an inquest was held as to the cause of the fire, and great complaints were made that the building was not incombustible in every part. With regard to the safety in the use of concrete, as a protection from fire, especially when the concrete was only a few inches in thickness, Mr. Tite expressed much doubt, considering it inferior to the York landings employed by himself as above mentioned. Mr. Farrell had sent to Sir R. Smirke a description with drawings of his method, and the reply of Sir Robert was that he had done the same thing himself for twenty years, only turning the girder with the flange upwards **T**, instead of downwards. Whether Sir Robert had done this in cast or in wrought iron however, and to what extent did not appear. He, Mr. Tite, should have used wrought iron joists upon Mr. Farrell's plan more generally, but for the improvements and popularity of cast iron girders; and should certainly have employed iron much more extensively, but for the great question of expence. He was very glad the subject had been discussed, as it would be of the greatest possible advantage, if a cheap and durable floor could be constructed, which should be fire-proof in the honest sense of the word.

Mr. T.-H. WYATT, V.P. considered that the present was not a question of precedency, but of general applicability; and as he had been one of the first to use Messrs. Fox and Barrett's system extensively, and had employed it to the extent of 1400 or 1500 squares, he begged to say a few words in its favor. In the Wiltshire Lunatic Asylum, erected by him, it was essential that the estimates should not be exceeded. Originally a judicious system of pugging had been contemplated, but by the adoption of Fox and Barrett's system, not one shilling had been added to the cost, and the results had been most satisfactory. He had tested the deflection of the joists employed, and found it very slight indeed, and he was convinced that any sound wall would bear the weight of this construction, amounting as it did to not more than 78 lbs. for each superficial foot of flooring. Mr. Wyatt confirmed the experience of Mr. Piper as to any needless doubts which might be felt respecting safety of the construction, until rigidity was imparted to it by the concrete filling in. This desirable result however was obtained in a most remarkably degree. In the building referred to he had used joists up to 16 ft. bearing, but others of larger bearings since employed had been equally satisfactory. He had felt some misgivings as to the possible decay of the wooden strips resting upon the joists, but he believed that, as Mr. Barrett stated, they might with safety be removed as soon as the concrete had set. The only serious doubt was as to the action of any damp which might arise from the concrete, supposing the wooden floor to be laid covering it before it had had time to become thoroughly dry. He had used a boarded surface of floor with this system, though if he were building a house for himself, he would prefer one of cement. There were (he believed) no wooden floors in the asylum built by Dr. Fox. With respect to the depth of the iron joists, he had examined Mr. Barrett's calculations, and was

convinced they were free from all possible risk, and might be made from a considerably reduced formula, and yet be within the mark of safety. Mr. Wyatt then adverted to the action of a body of flame upon ordinary plaster, and described some experiments made by Mr. Hardwick at the St. Katharine's Docks, in which plaster slabs $1\frac{1}{8}$ to $1\frac{1}{4}$ in. thick, screwed to the underside of the wooden joists, were exposed to violent flames from tar barrels, and shewed that very little fear need be entertained of the effect of fire upon a ceiling, even if the whole contents of the room were to become ignited. From this he inferred that the laths employed in Fox and Barrett's system did not constitute any objection to it; and he added that he considered it one which was really well deserving the attention of the Members of the Institute.

Mr. P'ANSON, Fellow, also spoke in favor of Fox and Barrett's system, and considered that although both that and the French system might have some analogy to the old methods described by Mr. Tite, they shewed a great advance upon those methods. The concrete and other substances were superior to York landing, inasmuch as they tightened up the joists, and gave its chief value to the construction. The elasticity of the joists, until they were filled in, was most remarkable, but in about six or eight months after completion, the floor became perfectly rigid. He had employed Mr. Barrett's system in a large dwelling house, 45 ft. by 26 in dimensions, and the cost of the iron did not exceed £90.; the whole of the timber being saved.

Mr. TITE explained that the York stone in Mr. Farrell's plan was perfectly connected with the iron by means of the cement.

Mr. BOULNOIS, Associate, stated that it had been asserted by Mr. Brunel, that the concrete was very liable to become disintegrated, and so to part from the joists in Fox and Barrett's system, and to leave them hanging up like so many laths. He had used the system for a 19 ft. bearing three years ago, employing joists without any upper flange, but the floor was subject to considerable vibration, which might be increased beyond the control of the architect—for instance, if used for dancing. He wished to know if the concrete formed a rigid slab equivalent to the stone employed by Mr. Tite; and whether in Mr. Barrett's experience he had ever found the concrete shaken off from the joists.

Mr. BARRETT said that he had not. The concrete could not be acted upon from below, nor from above, except by a complete disruption of the upper part. He considered that Mr. Boulnois was altogether begging the question by assuming the fact of vibration, which he could not allow to be taken for granted. After an experience of twenty years with bearings of as much as 18 feet, subject to all the ordinary wear and tear of a dwelling house, he could not conceive the possibility of such a result as the concrete becoming loose.

Mr. BOULNOIS could confirm Mr. Barrett's opinion by his knowledge of the floor at Messrs. Nurse's coach factory, in Regent Street. There was a sag in that floor, in consequence either of the joists not being cambered, or not being supported in the middle; but that sagging had never increased, although the floor was subject to very great vibration from carriages being moved over it, nor had the concrete been disintegrated. These, however, were matters which patentees ought to be able to speak to, without leaving architects to find them out.

Mr. BARRETT said that he had no means of finding out such a fact, which was not necessarily correct simply because Mr. Brunel had asserted its possibility. He must be content with referring to his own experience, confirmed as that had been by Mr. Boulnois himself.

Mr. TITE called attention to the question of Mr. Boulnois as to the degree of strength and rigidity of the concrete, taken alone; and objection to a wooden floor over the concrete on the score of expense.

Mr. P'ANSON adverted to the advantages of Portland cement for a flooring.

Mr. PIPER, Visitor, said that his own gateway was covered with rolled iron joists, filled in with common York paving, and then (to meet the requirements of the old Building Act) covered with concrete

so as to make a thickness of 14 inches. He had, however, ceased to use this method, observing that York paving was exceedingly destructible by fire, and that practically it did not furnish a fire proof floor. With reference to the doubt suggested by Mr. Boulnois, he believed the patent floors would be found to move altogether, if at all; that there was in fact a close union between the concrete and the metal, and no distinction in the amount of vibration of each. A floor over a stable, subject to all the wear of a loft and granary, had stood for six years (covered with Portland cement) without the slightest disintegration. Mr. Piper concurred with previous speakers as to the resistance of plaster to the action of fire, and therefore considered the laths used by Mr. Barrett were perfectly safe.

Mr. TITE enquired what experience there had been of the action of fire on concrete. He apprehended if there were flint stones in it the concrete would split and yield under the action of fire.

Mr. WHITE, Visitor, referred to the fire at Mr. Ald. Humphreys's warehouses, in February 1851, where he believed the concrete alone prevented the spread of the fire to the vaults, which were filled with valuable and combustible goods.

Mr. BARRETT read an extract from the Times Newspaper of the 21st February, 1851, in confirmation of this statement. He added that several fires had occurred in the building erected by Dr. Fox. On one occasion all the furniture in a room, and on another occasion a four-post bedstead and furniture, had been reduced to ashes without injury to the ceilings. Mr. Piper could probably explain the circumstances attending the fire at Messrs. Collard's manufactory at Camden Town.

Mr. PIPER said that there the upper floors were on iron girders, but not fire proof. The basement was covered with a light ceiling on Fox and Barrett's patent, and with ordinary care on the part of the firemen it would have preserved the property below. The firemen however would not interfere, and what was termed a second fire took place and destroyed the contents of the basement story. Mr. BARRETT read the official report of Mr. Baker, the district surveyor, to the official referees, describing in detail the circumstances referred to, and which concluded thus: "From the foregoing statement, there is no reason whatever to doubt the efficiency of Fox and Barrett's patent, when applied as a sound fire-proof party structure; on the contrary, I am well pleased with it, and even with its resistance to very great concussion, when the latter is spread over a surface; I only wish it had resisted the single and more *pointed* attacks as well as the combined." These "pointed attacks" refer to the fall of iron columns and girders from a height of 30 ft. upon a fire-proof ceiling, never intended to carry anything but itself.

Mr. TITE contended that York stone would not yield to a fire above it, and again inquired for any proof of the effectual resistance of concrete to the action of fire.

Mr. BARRETT said his system had resisted fire in dwelling houses frequently, but it had not been tested by a fire in any large warehouse.

Mr. SCOLES, Hon. Sec., observed, that if the ceilings were plastered where these fires occurred the concrete had not been tested.

Mr. HESKETH, Fellow, thought the case of Mr. Ald. Humphrey's warehouses unsatisfactory as a proof of the value of concrete. The fire did not get under that floor, and it was protected from above by the rubbish which fell upon it.

Mr. BOULNOIS contended it was the duty of the patentee to settle this point, which he might easily do by erecting an experimental house and setting fire to it.

Mr. DONALDSON, Hon. Sec. For. Cor.—No architect would use such a ceiling without plastering it, and it was in evidence that intense and long continued heat would not damage the plaster.

Mr. BOULNOIS complained that insurance companies made no reduction in their charges where the patent was used. If the patentees proved it to be fire-proof this object might be attained.

Mr. BARRETT said this rested with the proprietor of the building. The house in which his own offices

were, cost £3000. or £4000., and was only insured for £600., just to cover the little damage that could arise. Mr. TITE having referred to covenants to insure leaseholds to two-thirds the value, Mr. WYATT said he had advised the Wiltshire magistrates not to insure their lunatic asylum; and Mr. BARRETT said that in the case of the Royal Porcelain Works at Worcester, where his system had been introduced, the insurance had been reduced from 7s. 6d. to 1s. 6d. per cent.

Mr. C. H. SMITH, Visitor, referred to the causes which rendered some of the varieties of laminated York stone, used for fire-proof construction, more destructible by fire than others. Those termed self-faced, having been naturally divided, and containing more clay to absorb moisture, which would be converted into steam by great heat, and consequently split, were the most unfit for the purpose. Under ordinary circumstances he was of opinion that concrete, properly made, would bear a very considerable degree of heat; perhaps more than Yorkshire stone.

At the suggestion of the CHAIRMAN, the discussion was again adjourned.

ON THE FRENCH AND OTHER METHODS OF CONSTRUCTING IRON FLOORS.

Being a Discussion (in continuation) held at the Ordinary General Meeting of the Royal Institute of British Architects, February 6th, 1854.

THE Discussion of Mr. Burnell's paper "On the French Method of Constructing Iron Floors" being resumed, Mr. C. C. NELSON, Hon. Sec., observed that on comparing the French and the English systems, which had been brought under consideration, one great point of similarity was found between them, inasmuch as the main supports in each were the rolled iron joists; on the other hand these joists were much closer together in the English than in the French system, in which latter, however, the iron entretoises, or transverse rods, were placed further apart than the wooden laths in the English system; while the material used for the filling in differed materially, being plaster of Paris, or plaster and hollow earthenware pots in one case, and concrete, formed of lime, sand and gravel, in the other. Neither of the systems under discussion could be considered perfectly novel; and indeed, so far back as the year 1849, a paper was read to the Institute by Mr. Donaldson, describing a mode of construction adopted by an engineer named Thompson, in a bridge over a railway near Glasgow, in which tubular iron girders, of boiler plate $\frac{3}{8}$ in. thick, were made solid by the introduction of concrete between the plates to render them unyielding and rigid; the girders being then tied and framed together with bars of iron, the space between them was filled in by arched brick work. With reference to the question which had been raised at the former meeting as to the expansion of concrete, Mr. Nelson referred to the "Essay on Concrete," by Mr. Godwin, in the first volume of the Transactions of the Institute, for which the first medal of the Institute was awarded in 1836, as containing (in pages 23, 29, and 39,) the results of experience on the subject, clearly proving that concrete in setting did expand. As to the nature of the French plaster, M. Delassaux had forwarded the following communication in 1846, describing the difference between that material and the "plaster of Paris" used in this country, from which it would appear that the former was a much better material than the latter:—"The English plaster stone is a sulphate of lime, destitute of water, except a small portion of sulphuric acid; it is in fact an imperfect alabaster. The consequences of the chemical composition of this stone are, that burnt and reduced to powder in the usual way, it is not capable of resisting the vicissitudes of the weather, and the small quantity of sulphuric acid it contains prevents its setting quickly or becoming hard. It can consequently only be employed for interior plastering, and generally for works requiring but little solidity—its employment in construction is thus very limited. The stone of the French plaster of the environs of Paris is a sulphate of lime composed in the best proportions, the acids being almost equal to the bases; properly burnt it preserves all its acid properties, and reduced to powder and mixed it becomes very hard in one day. Unlike the English plaster there is no need to grind it very fine, on the contrary for strong work it is better to be rather coarse; it is only in decoration that it is employed as fine as the English. In France, along the borders of the Seine, the houses are constructed with this material; for solid construction, grouting the joints of stones, for exterior and interior decoration, and masonry generally, plaster of Paris is employed; for the latter purpose the powder is used rather coarse; mixed with water it forms a factitious crystallization, which adhering to the materials employed gives them greater rigidity—thus a vault formed of stones badly dressed and ordinary mortar would have but little strength, but the use of plaster with its properties of adhesion and augmentation of volume would insure solid and durable work." In February 1849, Mr. Charles Barry read a paper describing a system, patented

by Mr. Beardmore, C.E., in which the same reliance was placed upon concrete, formed of Portland cement and shingle, for stiffening wrought iron, as in Messrs. Fox and Barrett's flooring, drain pipes being in some cases introduced with the concrete for the purpose of lightness. For a span of 20 ft., iron plates, 12 in. deep, $\frac{1}{8}$ in. thick, and 2 ft. 6 in. apart, were used, a layer of concrete, 5 in. thick, being placed between them, on horizontal plates of iron, $\frac{1}{16}$ thick, secured by rivets to the sides of the upright bearers. The author thus described the use of the concrete. "The uniform pressure of the concrete against the surface of the web, and under the upper flanges of the beam, produces the effect of a continuous strut, and enables any sheet, however thin, to assume the true character of a beam or girder." For a span of 15 to 18 ft. the depth of floor would be $7\frac{1}{2}$ in.; from 16 to 20 ft., 12 in. Mr. Beardmore "considered his floors to be fire-proof from their mode of construction; not liable to disintegration when exposed to fierce flame, as brick arches are by their falling off in flakes, nor to be destroyed by sudden cooling when highly heated. The thinness of the floor, when contrasted with one of cast iron, and the absence of all lateral pressure, and consequent necessity for tie-bolts, were further advantages; in addition to which the concrete was a necessary element of the floor itself, not a weight independent of it, and it rendered the whole, as it were, one continuous beam, thus making it nearly impossible to accumulate a great weight on any one spot." Mr. Nelson added that he had received communications on the subject under discussion from Mr. C. H. Smith and Mr. G. R. Burnell, who were now present.

Mr. H. H. BURNELL, Associate, read the following extracts from letters which he had received from Paris, in reply to questions which he had forwarded since the first evening's discussion.

From M. Piot, Sub-Architect employed at the works of the Tuileries and Louvre:—

You ask me for some account of the iron floors we are now using in the new buildings of the Louvre. These floors are generally composed of girders and joists of the **I** form. The joists are so proportioned that the deflection of the floor under a load of 700 kilog. per superficial metre, or 143 lbs. per square foot, shall not exceed 20 centimetres (or $\frac{3}{4}$ in.) which may be thus explained: We suppose that four persons might stand in the space of a superficial metre (or $10\frac{3}{4}$ square feet), and that their joint weights might equal 300 kilog. or 661 lbs., we add as the weight of the interties, fantons, pottery, small wooden joists, and floors, 50 kilog., making 350 kilog. We double this load to make it equal to walking or dancing, and thus we arrive at the above named 700 kilog. (1544 lbs.). M. Piot gives the following Table of the spans, weights, and depths of the joists employed in the floors of the Louvre:—

SPANS.		WEIGHT OF JOISTS PER YARD RUN.	DEPTHS OF JOISTS.
Ft.	In.	lb.	Inches.
6	7	18	4
9	10	22	$4\frac{3}{4}$
13	2	40	$5\frac{1}{2}$
16	5	50	$6\frac{1}{4}$
18	1	54	$7\frac{1}{8}$
21	5	60	$7\frac{7}{8}$
25	0	76	$8\frac{3}{4}$

We have adopted the above mentioned spans, placing the joists 80 centimetres, or 2 ft. $7\frac{1}{2}$ in. from centre to centre, the interties 1 metre, or 3 ft. $3\frac{1}{3}$ in. apart; the fantons are placed 20 centimetres, or $7\frac{7}{8}$ in. from each other, and serve to support the pottery in the usual way. The pottery is thoroughly bedded and plastered on both sides, rendering the floor as nearly as possible sound-proof, and infinitely

superior in this respect to the ordinary methods. The strength may be judged of by the fact that some have been proved to 1500 kilog. per superficial metre, or 307 lbs. per square foot, and the deflection did not exceed 3 centimetres, or 1 in. in the middle. In first class buildings the filling-in is generally of pottery or hollow bricks, but in private houses they usually content themselves with plaster alone, it is considered inferior and less sound proof. In general the wrought-iron floors are found to be of the necessary strength, and may be regarded as a great improvement, but in France, and particularly in Paris, the spirit of speculation is prone to exact too much from the material it employs.

From M. Lebas :—I received the letter you were good enough to send me, and was glad to hear that you had written to M. Piot on the subject, for he is the most capable of giving the desired information, as he unites great experience with practice, which is better than all the theories. He has no doubt given you all the necessary proportions of the floors of the Louvre. Though it is certain that with these floors there is a small amount of vibration, it is no less certain that when used with common judgment they offer the desirable qualities of strength, durability, and incombustibility. Had I to undertake a building of importance I should unhesitatingly adopt this system, which I consider excellent.

M. Charles Hittorff remarks that, for dwelling houses, the weight on the entire floor should not exceed one-fourth or one-fifth of the breaking weight, or limits of deflection of the joists, and that it should bear the weight of four persons = 300 kilog. (661 lbs.) per superficial metre (66 lbs. per foot superficial). When these limits are surpassed, a disagreeable vibration and a disposition to transmit sound is the result. As yet, the floors well filled in with pottery, or hollow bricks, have developed no symptoms of failure, either with respect to vibration or transmission of sound; but they are considerably dearer than those of wood, though the manufacturers (quoting the first or cheapest system) pretend the contrary. This kind of economy is much to be regretted, as it may be the means of causing accidents, which would tend to create a prejudice against this mode of construction. The difficulties of rolling render the production of large joists very doubtful as regards the equality of texture, and in many instances those of from 22 ft. to 24 ft. long, and from $8\frac{1}{4}$ in. to $10\frac{1}{4}$ in. deep, have broken on being proved; but nothing is to be feared from the employment of these methods for moderate spans.

M. Hittorff has never known that these iron floors have been filled in with concrete, which, in his opinion, would be to load the floor unnecessarily. The iron work is painted with a coat of litharge to prevent oxydation; sometimes this precaution is neglected, and without ill effects; for after all, the oxydation can only take place by the double action of the oxygen of the air and water. The iron embedded in plaster is at once covered with a coat of rust, but this action soon ceases when the plaster is of a sufficient thickness (say $\frac{3}{4}$ in.) to exclude the air. This fact is sufficiently proved by the fragments of iron we constantly find, while demolishing our old buildings, in a perfect state of preservation, though they have never been painted.

Lastly, a communication from M. Dumont: Of the two systems of wrought iron floors that you mentioned, this one is almost exclusively employed here. Prudent builders never allow the depth of the joist to be less than $\frac{1}{36}$ th part of the span. The filling in between the joists is generally of pottery or hollow bricks, bedded in plaster; when the builder is not too sparing of his plaster, and the spaces properly filled in, the necessary rigidity is obtained. We avoid the use of concrete, on account of its weight; we find nothing answer so well in every respect as the pottery. We paint our iron work with one or two coats of litharge, according as the speculator may be disposed. As to the quality of the work, I may state that, up to the present time, the ceilings have not suffered from discoloration by the oxide of iron; I believe that, in the first instance, the paint is sufficient to protect the iron from the humidity and the corrosive qualities of the plaster, and at a later period, the plaster in its turn protects the iron from atmospheric influences. It must be acknowledged that experience, as yet,

can say little on the matter. In twenty, fifty or a hundred years, we shall be better able to judge of the systems, but at the present moment they are so much in favour with us, that we very rarely have recourse to the old methods. In four houses that we are now erecting in the Rue de Rivoli we have used these floors, three of them opposite the Tour de St. Jacques, and the other (which is the most important) between the Rue de Bourdomais and the Rue des Déchargeurs; we do not yet know the numbers.

Mr. BURNELL then read the following remarks:

From these communications we may briefly sum up the following facts:—That the planchers en fer, if properly carried out, succeed, but that they, in common with all other modes of construction, are capable of being executed badly. We learn that the floors of the Louvre, though upon the same principle, are stronger than those ordinarily used for dwelling houses. That joists of the depth and weight indicated in the table furnished by M. Piot, if placed 2 ft. 7½ in. apart and properly filled in, will produce a floor whose deflection shall not exceed ¼ in. in the centre, under a load of 143 lbs. per superficial foot; and that there are others executed in the Louvre that have borne 307 lbs. per square foot, with only 1 in. deflection in the middle. That for the floors of dwelling houses, the weight on the floor should not exceed one-fourth or one-fifth of the breaking weight of the joist, or that the depth of the joist should not be less than ⅓rdth of the span, when placed about 2 ft. 6 or 3 ft. apart; and lastly, that no ill effects have at present been experienced from the contact of the iron with the plaster.

As I have before said, my object in drawing your attention to the matter in question was to induce a due appreciation of that which seemed successful, but not to extol it beyond its merits. I think we must all perceive that a valuable lesson is to be learned by the study of these French methods, when we consider their lightness, and the small space they occupy, when compared with the fire-proof floors we have been in the habit of executing. The introduction of interties between the joists must surely be important, when the filling-in is of a material that swells in the process of setting, to say nothing of their use as transverse ties. The ceiling appears to offer its advantages on the score of durability and convenient execution; for how much more easy must it be for the workman to adjust a flat centering beneath the joists, and form the ceiling by the simple operation of pouring a composition in upon it, than the tedious process involved in our own method of lathing, and applying the various coats of plaster, in a very inconvenient position, from the under side. This mode of grouting from above is not peculiar to iron floors, but it requires a material that sets with moderate rapidity, which with us is more costly than with the French.

I believe that the rare occurrence of serious conflagrations in France is mainly attributable to the use of solid plaster ceilings. All seem to agree that the frequent losses by fire, the discreditable condition of many newly-built houses, the fall of others, and the threatening aspect of the many more which must inevitably share the same fate, were there not a special Providence over ignorance and knavery, are sufficient causes to justify any attempt to introduce improvement; and when we consider the rapid occupation of very desirable positions by endless piles of mud and bricks, exhibiting little but a disposition to speculate and low cunning, we must all regret that our already great metropolis should continue to extend itself under the guidance of parties so little capable or disposed to develop constructive or artistic talent.

Mr. CHRISTOPHER, Fellow, felt called on to offer some remarks upon what had been called the English system, as the results of considerable experience. He had spoken warmly in favour of that system when it was first introduced, and still thought well of it, though it had not been so much improved as he had expected. With regard to the kind of finished flooring used upon the concrete, he observed that Portland cement in connection with elastic iron was objectionable from its rigidity and brittleness; and in many instances within his own knowledge it had cracked. Indeed, he did not know of a case in

which it had remained sound for three years. This had been the case both with floors and with flat roofs, after remaining perfect for twelve months; and, as they were aware, when the Portland cement was once cracked, water spilt would penetrate through the concrete, and in the case of a floor would stain the ceiling below, whilst in that of a roof the damage would be much more serious; as there it was impossible to repair effectually the cement. It was difficult to account for this failure, but probably, as one of Mr. Burnell's French correspondents suggested, it might be owing to the expansion of the concrete. Whether the fault was in the cement or in the concrete, he had had failures in three roofs. However, the system admitted of other modes of finish, and amongst these he might observe that he had found the metallic lava of Messrs. Orsi and Armani quite successful after two years trial. The ceilings on the French system were, in his opinion, better than those on the English plan. In the latter there was the want of a good key, and this was a serious objection where the plaster was $1\frac{1}{4}$ or $1\frac{1}{2}$ in. thick, while under the flanges of the joists and girders there was no key at all, and several serious falls of the ceiling had taken place. In the French system this could not happen, the whole mass being poured in from above; but in the English a separate material was applied to form the ceiling from below. As the object of this discussion was to ascertain the truth, he felt bound to say there had been several instances of ceilings giving way, not only under roofs, perhaps from the faultiness of the cement coating, but also in the floors below, and he had found it necessary very recently to take down the whole of several ceilings, in order to quiet the apprehensions of the tenants on this score. Another serious objection to the English system, especially in London, where expedition was required and ground rents high, was the time necessary for the materials to dry. The drying of a mass of material 8 or 9 inches thick and full of water, if in a confined situation, was indeed almost an impossibility. He had a case in which it had not dried even in two years, and in which it had been necessary to take up the surface of the lower floors entirely, and to employ another material. The floors in that case had been of lime and sand; after the building had been shut up for two months, the workmen (who were provided with slippers) went in to hang the doors, and the surfaces were consequently so worn and broken that they were destroyed. In the lower part of this building Portland cement was substituted for the original finish, and he might observe, as an exception to his former statement, that as a basement finish that material, about $1\frac{1}{4}$ in. thick, answered exceedingly well, the damp tending to preserve it. In this case the cement was laid on a concrete bed, 4 to 5 in. thick, upon the well rammed earth. As he had remarked some years ago, Fox and Barrett's system admitted of the best plans of ventilation and artificial warming, but this point did not appear to have been much attended to. This, indeed, with such a mode of construction, was more necessary than in the ordinary plan. The floors were so solid from wall to wall that no air could get through them, and therefore a special supply was necessary. From the same cause there had arisen a want of draught to the fire places, and consequently smoky chimnies. Mr. Christopher then proceeded to the question of cost, in which he differed altogether with Mr. Barrett. He had gone into estimates with that gentleman when iron was only half its present price, of £15. per ton, and they could not reduce the price of a floor on his plan to the cost of an ordinary timber floor; on the contrary, it was about the cost of a timber floor of the best description, made in the best way. He objected to the course pursued by Mr. Barrett in his calculations read at the last meeting, and to the deductions he had made from the price of his floors in order to bring the cost down to the lowest possible figure. Thus Mr. Barrett made a deduction for an assumed excess of strength, but he (Mr. Christopher) could not admit that for a moment. To any person employing his patent, Mr. Barrett would certainly not recommend any reduction of strength to correspond with this deduction from the price. Indeed, instead of making any deduction from the cost of the patent system, he (Mr. Christopher) thought certain additions should be made. In the first place better foundations were required than for ordinary construction. These would be necessary even in the

country, on a maiden soil, and in a second rate house in Pall Mall he estimated the extra cost for the foundations, which were essential in using this solid and massive description of fire proofing, at £20. In the Thames Chambers, an extra first rate building, upwards of 10,000 feet of hoop iron were used, at a cost of £46., rather more than half of which, or £25., he had considered necessary in consequence of adopting Fox and Barrett's system. Then again, there was the license for the use of the patent to be added, which, in a dwelling house, would be from £10. to £30. It did not appear, moreover, whether the hoisting and fixing of the joists were included in Mr. Barrett's price. [Mr. BARRETT said they were included]. Then expense was incurred in cutting and trimming the joists for chimney breasts and projections which in the case of the Thames Chambers, where there were fifty-five squares of flooring, he estimated at £10. There was the painting the lower flanges of the joists, which he thought very advisable, and more so after inspecting the result of Mr. Smith's experiments on the table, and which the French architects appeared also to think necessary. [The Chairman, Mr. T. H. WYATT, said, the statement of M. Hittorff was that the painting might be dispensed with; that its absence did not seem to produce any ill effects.] In all good rooms it would be also necessary to have a wooden fillet for nailing the carpets to. Mr. Christopher's estimates, framed on the result of his experience, would therefore be as follows:—

FOR A ROOM 12 ft. × 12 ft. = 1 sq. 44 ft.		£.	s.	d.
Fire-proof floor with cement surface—Mr. Barrett's price, omitting his deduction.....		7	14	10
Add for extra foundation and bond		1	3	0
License for use of patent		0	14	4
Hoisting, fixing, cutting, and painting—say.....		0	7	10
		10	0	0
Add extra for boarded surface		1	16	0
		£11	16	0
Cost of timber floor, pugged—Mr. Barrett's price...		8	15	4
Excess in cost of fire-proof floor		£3	0	0

FOR A ROOM 20 ft. × 20 ft. = 4 sq.		£.	s.	d.
Fire-proof floor with cement surface—Mr. Barrett's price, omitting his deduction		32	4	3
Extra coat on ceiling, 44½ yds.—at 2d.		0	7	5
Extra foundations—at 7s. per sq.		1	8	0
Extra hoop-iron bond—at 9s.		1	16	0
License for use of patent—at 10s.		2	0	0
Hoisting, fixing, cutting, and painting—at 5s. ...		1	0	0
Wood filleting for carpets—say		1	0	0
		39	15	8
Add extra for boarded surface, with 1½ in. battens, at 32s.		6	8	0
		£46	3	8
Cost of timber floor and ceiling of best description, Mr. Barrett's price		31	12	3
Excess in cost of fire-proof floor ...		£14	11	5

Upon the whole, therefore, he thought Mr. Barrett's estimates were not to be depended upon.

Mr. C. H. SMITH, Visitor, called the attention of the Meeting to some specimens in illustration of the effect of plaster upon iron. In these specimens he had placed different materials in contact with iron on the day after the last meeting (a fortnight ago), and the results were now evident. In one specimen plaster of Paris alone was used, in another plaster mixed with sand, and in another mortar, or lime and sand in equal proportions. In the latter not the slightest trace of rust was perceptible, although the interior of the mass was still in a very soft state, whilst in the other specimens, especially with the plaster of Paris, the iron was sensibly affected. Plaster of Paris decreased in hardness in proportion to its age. As an illustration of this, Mr. Smith stated that he was employed some years ago to remove from the residence of Mr. Prince Hoare, at Bath, to London, eight or ten large casts from the antique, which had been there a hundred years, but he only succeeded in removing two of them safely, the rest having fallen entirely to pieces. Lime, on the contrary, increased in hardness with age, and iron in contact with it was not affected. As the specimens proved, plaster was most injurious. Paint would protect the iron, but if it became rubbed off, even in the smallest pin hole, the plaster would communicate oxydation to the iron, to an extent almost beyond

belief, and, in fact, would in time entirely destroy the iron. He believed it would be found almost impossible to fix iron joists in a building so that the paint or other coating used to protect it should not be rubbed off in some parts, and even galvanized iron was subject to the same objection.

Mr. GARLING, Fellow, enquired if the old casts referred to by Mr. Smith had been exposed to damp.

Mr. SMITH said they had not; but that there was always a sufficient amount of moisture in the atmosphere to facilitate the decay of plaster.

Mr. GARLING referred to some plaster floors which he had seen in Lincolnshire, in the vicinity of the quarries. These consisted of a body of coarse plaster, with about an eighth to a quarter of an inch of fine plaster as a surface, very finely and smoothly trowelled; and although these were from 100 to 150 years old, they were now as hard as marble. He had also occasion to take down the plastering of the walls of some rooms in the same neighbourhood, which was at least 300 years old; this was 30 or 40 years ago, and, speaking from recollection, his impression was that the plaster in that case was quite as hard as in the floors.

Mr. SCOLES, Hon. Sec., suggested that these floors were possibly of lime, and not plaster; but

Mr. GARLING was quite sure they were of plaster.

Mr. G. R. BURNELL, C.E., referred to the work of Rondelet—*L'Art de Bâtir*—on the different nature of lime and plaster as to durability, in confirmation of Mr. Smith's remarks, and read some portion of his letter to Mr. Nelson: "I would call your attention, and that of the members of the Institute, to a work I mentioned on the last evening; it is M. Eck's '*Traité de la Construction, Poteries, Fer, Fonte et Tôle*,' in 2 vols. fol. Paris, 1841; in which will be found many very remarkable illustrations of the application of those various materials to purposes which rarely are thought of in England. It is an extremely valuable work, and if it had been better known here, probably much money might have been saved by preventing parties from taking out patents for systems already largely employed; and at any rate, the study of M. Eck's book would have suggested many valuable hints to both architects and engineers. At the same time, I would also beg to call the attention of the Institute to a Note I published myself in the *Builder* of 1849, page 350, in which I gave a short description of the application of the H shaped rolled iron: I allude to this because I have reason to believe that the application of this kind of bar iron to flooring purposes has been patented subsequently to the publication of my note in the *Builder*. In Paris, it was used, to my knowledge, in 1848." The nature and application of compound wrought iron beams with earthen pots for roofs were described by Eck as known so long ago as 1780, in whose work an account was given of the church of San Vitale, at Ravenna, the dome of which is formed of oil jars, laid horizontally; a fact which would set at rest the question of the supposed novelty of this use of pottery.

Mr. SCOLES, Hon. Sec., referred to the use of similar materials, in the Roman period, in Syracuse, and Mr. DONALDSON added also that they were employed likewise in the Circus of Caracalla.

Mr. G. R. BURNELL read a further portion of his letter to Mr. Nelson:

"The formulæ given by General Morin are as follow: 1st. For the system Vaux, he considers that the bars are exposed to the action of a load distributed equally throughout their whole length, and that the ends are fixed in the walls; the weights and dimensions are calculated in metres and kilogrammes. Then, calling the height of the bars, or main ribs = b

Their width - - - - - = a

The load per metre lineal - - - = p

The clear span - - - - - = C

The coefficient of the resistance of wrought iron = 2,000,000

$$ab^2 = \frac{p C^2}{2,000,000}$$

In practice, the load per metre lineal usually applied (at least, for the purposes of calculation) is 53.28 kil., or about 37 lbs. per foot lineal; and the joists or bars are placed at distances of about 2 ft. 6 in. apart.

"2nd. In the cases where rolled **H** rails are used, the height b , and the projection of the flanges a' , are constant for the same class of rail, and the thickness of the flanges is usually $\frac{1}{20}$ th of b . The thickness of the centre web e' is the only element of the problem in these cases which varies, according to the resistance to be given to the bars. Then, calling the total load $= 2P$, and the total bearing $= 2C$, and the resistance for this form of section R , $= 6,000,000$, we have

$$\frac{I}{v'} = \frac{1}{6}e_1b^2 + 0.0903 a'b^2;$$

in which I = the moment of inertia of the section in function of the height b , and v' = the height of the neutral axis of the bar. The ordinary formula $\frac{RI}{v'} = PC$, then becomes

$$\frac{1}{6}e_1b^2 + 0.0903a'b^2 = \frac{PC}{R} = \frac{PC}{6,000,000} \text{ and from this}$$

$$e_1 = \frac{PC}{1,000,000b^2} - 0.54a'.$$

When the proportions between the thickness of the flanges and the height differ, the general formula becomes $\frac{I}{v'} = \frac{1}{6} \frac{ab^3 - a'b'^3}{b}$, in which b' = the space between the ribs.

"I was not quite correct in the observations I made upon the deflection of these floors, on the occasion of your last meeting, and I therefore send you a translation of an experiment recorded in pages 331 and 332 of vol. IV. of General Morin's '*Leçons de Mécanique Pratique*,' which treats of the resistance of materials.

"A floor of about 23 ft. span (7 mètres), on the system Vaux, with joists 2 ft. 6 apart, $7\frac{1}{2}$ in. deep by 0.36 of an inch in thickness, cross ties 0.63 of an inch square, and split rod laths 0.43 of an inch square, the joists bearing about 1 ft. on the walls, was loaded with a weight equal to 102 lbs. per foot superficial over the whole surface. The iron work was set with a camber of about $2\frac{3}{4}$ in. when in place; the filling in with plaster brought this down to 1.58 in.; and when the load was applied, the floor sunk to 1.17 in. below the horizontal line, which deflection ultimately became (after 24 hours) 3.17 in. On removing the load, the floor rose 2 in., and on further removing the plaster filling the iron work, rose nearly to its original camber, or to 2.36 in. above the horizontal line. General Morin remarks that this proves that the iron retained its original elasticity to a great extent, and that the plastering contributed greatly to the permanent deflection.

"Mr. Barrett's objection to the use of the French floors—that they were not perfectly inflexible, and his statement that the plaster used in the Midland Counties was objected to on account of its organic smell, seem both to require notice; for, in the first place, a mere augmentation of the scantlings would give any required rigidity; and, in the second, Mr. Barrett appears to have overlooked the fact that the French plaster, both geologically and lithologically, differs from that of our Midland Counties."

Now, the French plaster contained carbonate of lime, which the English plaster did not. Possibly English plaster, used in large masses, might give out some odour; but certainly he could state from experience that the plaster used in Paris was not open to that objection. Where French plaster was used in conjunction with brick-work, a remarkable degree of efflorescence took place, which might arise from animal matter either in the bricks or in the plaster, or perhaps in both. At all events

animal matter did not exist in the French plaster to any objectionable extent. Mr. C. H. Smith's statement that lime protected iron from rust should be received with caution. All the wrought-iron bridges in France had been built upon the principle laid down by Vicat, that no oxydation could take place whilst iron was immersed in slacked lime; and accordingly the tying-down rods of these bridges were bedded in wells, with a paste of chalk lime carefully rammed in. Yet all those bridges had fallen; that at Angers at a time when 600 person were upon it, more than 400 of whom were drowned. The explanation of this failure possibly was, that the action of the load upon the bridge set the chains in a state of vibration, which, though not perceptible to the eye, was yet sufficient to detach the rods from the lime in which they were embedded; upon which water could get in, and the oxydation would commence. Mr. Smith's principle was correct; but in a floor of any kind there must be some degree of vibration, which would tend to detach the joists or girders from a bed of lime in which they might be placed. He believed, in fact, that concrete or lime in any form was not better than plaster, which being more hygrometric than the mortar would rather protect the iron more securely. Practically, in a house, the plaster was a sufficient defence to the iron, and this was what the French architects meant, when they said they had not noticed any rust in the use of this material.

Mr. SMITH observed that it was not necessary that lime should be absolutely in contact with iron to protect it from rust. Thus the dealers in polished steel goods, such as needles, did not coat every article with lime, but merely placed here and there amongst them a piece of quick lime in paper, which kept them in a polished state as long as the lime continued in a caustic condition.

Mr. G. R. BURNELL said that this remark did not apply to the French bridges. In the case put by Mr. Smith, the caustic lime not being as yet converted into a hydrate, acted by absorbing moisture from the atmosphere.

Mr. GARLING suggested that if the chains of the French bridges were bundles of wires instead of solid bars, the interstices in the wires might have conducted the water into the wells.

The CHAIRMAN stated that the names of two gentlemen had been given to him as wishing to offer some remarks upon the subject; and that it would be only fair to Mr. Barrett to allow him to say a few words in reply to Mr. Christopher. As therefore the discussion had already occupied the usual time, he proposed that it should be further adjourned till the next ordinary meeting.

Mr. BARRETT, in reference to Mr. Christopher's statement that extra foundations were necessary in using the patent system of flooring, begged to appeal to Mr. Beck, who might not be able to attend at the next meeting. As architect to the Metropolitan Association, that gentleman had erected a building five stories in height, all the floors as well as the roof of which were fire-proof; and he would no doubt bear testimony to the fact that extra foundations were not used there.

Mr. BECK, Associate, said that this was the fact, and that, in the case referred to, he had not introduced any additional brickwork in the foundations, in consequence of using Messrs. Fox and Barrett's floors.

The discussion was then again adjourned.

ON THE FRENCH AND OTHER METHODS OF CONSTRUCTING IRON FLOORS.

Being a Discussion (in continuation) held at the Ordinary General Meeting of the Royal Institute of British Architects, February 20th, 1854.

THE discussion, which had already occupied the attention of the three previous meetings, was resumed by Mr. C. C. NELSON, Hon. Sec., reading the following communication from Mr. H. J. Stevens, Fellow, of Derby.

“I beg to offer the following information as to the nature of the floors to which Mr. Garling alluded during the discussion at the Institute on the 6th instant.

“Gypsum, or plaster, from the quarries near Derby, and parts of Nottinghamshire, is very extensively used for chamber flooring in this district—and its durability, when properly prepared and laid down, fully equals what Mr. Garling asserted. The coarsest description of gypsum is used, and after calcination, is broken down with wooden flails. It is kept in a dry state, and when laid, is mixed with water to the consistence of rough mortar, and spread over the wood joists on reeds or laths to a uniform thickness of 2 inches to $2\frac{1}{2}$ inches. It hardens very rapidly, and the workmen use a long float of wood for levelling it, and on the second or third day, it is polished off with boulder stones or trowels. It is desirable that the surface should not be broken by using the floors too soon after they are laid: it is also usual to give an increased hardness by a coat of linseed-oil, and in Nottinghamshire the floors are painted, and look extremely well. Two sides of the room have wood fillets laid down, varying in thickness with the superficies of the floor, which being removed immediately after it is laid allow for the expansion, which is not only very considerable, but continues for some time. Floors of this material are very strong, and are extremely well suited for cottages, being, in this district, much cheaper than inch white deal—2s. 3d. to 2s. 9d. per superficial yard is the builder's price for laying them down, including reeds, laths for securing the reeds, and plaster. The under surfaces of the joists are edged, and sometimes planed, and the ceiling is formed by the plastering of the reeds between the floor timbers, for which an extra 3d. per yard is sufficient. These floors are to a certain extent fire-proof, and having a smooth surface are easily cleaned, and afford no harbour for vermin; on these accounts, as well as for their cheapness and durability, plaster floors, as they are called, are almost invariably adopted in the Midland Counties, where the carriage of the material does not operate as an objection. Mr. Garling is wrong as to the *finer quality* being laid over the coarser material. I believe what is herein stated will give you the detail of the process, and I have only further to observe, that it admits of being burnt over again, and it is considered desirable that a certain proportion of old plaster should be mixed with the new; when that is the case the floors are found to set harder. I have seen this coarse flooring plaster used externally as pane work in half-timbered construction, and believe it to have been two or three hundred years since it was worked into the building.

“I offer these observations for the information of the members of the Institute, as there does not appear to be a clear notion of the uses to which the gypsum of this neighbourhood has been applied for many centuries. It is not improbable that the material may be adopted for flooring in connexion with a system of fire-proof construction, and it might be desirable for some of our scientific members to examine and analyse its composition. I am disposed to disagree with Mr. Christopher as to the extra expense necessarily incurred by the adoption of Fox and Barrett's

system of fire-proof construction, but as the Chairman of the last meeting has given Mr. Barrett an opportunity of replying to Mr. Christopher's statement, I have no doubt that gentleman will easily bring proofs that neither extra foundations, nor hoop-iron bond are required, that the hoisting, etc., are included in Mr. Barrett's statement of *cost*, and that wood filleting for carpets cannot be necessary where a boarded surface is added."

Mr. T. H. WYATT, V.P., having before expressed a strong opinion in favour of Messrs. Fox and Barrett's system, was anxious that it should not be supposed that he had adopted it without mature consideration. He had heard with surprise and pain the strong remarks of Mr. Christopher, objecting to this system, for he could not but remember that his own attention had been first directed to the patent by a pamphlet of Mr. Christopher's published in 1848, which eulogised the system in a manner, compared with which, any praise which he (Mr. Wyatt) had given to it, was as cold as possible. Certainly, his own experience, together with that of his friends, Mr. Salvin, Mr. Clarke, Mr. Rhode Hawkins, and others, who had used it largely, justified the opinions he had already expressed. He, himself, had never used it for roofs; neither had he used cement floors; and he was strongly of opinion that the failures which Mr. Christopher referred to, had arisen from an injudicious application of the system rather than from any inherent defect. A principal objection raised by Mr. Christopher, was the want of a good key for the ceilings; but having used the system successfully in four or five large buildings, especially in the Wiltshire Lunatic Asylum, where, from the constant vibration in the refractory cells and in the corridors, the ceilings were subjected to the severest test, he felt convinced that any failure elsewhere must have proceeded from bad workmanship; and in this opinion he was confirmed by the friends already mentioned. With respect to the time necessary for the drying of the concrete, he thought it rather desirable than otherwise, that a check should be given to the rapidity with which buildings are now carried up; and in his own practice, he had not found the difficulty to exist with a proper supply of air and provision of fire-places, which did not exist in one of the buildings erected by Mr. Christopher. Mr. Christopher, in his pamphlet, had thus described the excellence of the ceilings at *Northwoods*:—"The ceilings are finished, and appear as usual, but equalling the best, as they remain for fifteen years without a crack!" Mr. Christopher had objected to the solidity of the patent floors, as interfering with the supply of air to the fire-places. He (Mr. Wyatt), thought it was much better to depend upon an artificial supply of air than upon that which came through the interstices of the floor, bringing dust with it; and the objection, if any, applied equally to a good wooden floor, properly tongued and pugged. On the question of cost, Mr. Christopher had now given an opinion directly at variance with that expressed in his pamphlet, in pages 3 and 7, of which he stated that, "Buildings may now be constructed fire-proof without increasing the cost of erection; the above *grand desideratum* in the art of building is now no longer *theoretical*, but a fact supported by just such testimony as could be desired, viz, the existence of a building on a large scale erected throughout in the manner referred to, *which has not cost more* than if it had been constructed in the ordinary way. The roofs—at from one-half to one-third the cost of the usual roof.—*Economical*, rather less costly in first construction, and *much* less in use, from being *indestructible*." As he (Mr. Wyatt), had before mentioned, the adoption of Fox and Barrett's system in the Wilts Lunatic Asylum, had not involved the expenditure of an additional shilling beyond the original estimates. He certainly could not suppose that any extra strength in the foundations was necessary in this system. The only difference in the weight sustained by them, as compared with a case where ordinary floors were used, would amount to four hundred weight on the square foot in a building of five stories; and no prudent architect would make foundations so weak that they could not sustain so small an extra weight as this, a tithe of the crushing weight.

In his pamphlet, Mr. Christopher had expressed a very different opinion, and stated that, "the requisite strength is fully developed by combination and perfect union, giving equally sustained solidity to every part, while from the lightness of the floors and roofs, and their being quite level, (without lateral thrusts) the enclosing walls need not be thicker than usual." For the same reason, he (Mr. Wyatt) did not conceive the use of an extra quantity of hoop iron bonding at all necessary. In the case of the Thames Chambers, referred to by Mr. Christopher, the nature of the locality might have suggested this precaution, which under ordinary circumstances was unnecessary. The objection raised as to the expense of cutting and trimming joists to suit openings and chimney breasts, bore rather hardly upon the system, especially as the patentees took great pains to prepare their joists and girders accurately. Generally, Mr. Christopher had been very severe upon the estimates of Mr. Barrett. He (Mr. Wyatt), had not gone minutely into those estimates, but he had sent them to a Surveyor in whom he could place confidence, who stated that they were perfectly honest, and applicable to the present time. It was not fair to compare this system with a wooden floor, as it should rather be compared with the French or some other kind of fire-proof flooring, and if that were done, he believed the result would be in its favour. After a long discussion on the subject, the Institution of Civil Engineers had approved of the plan, the Inspectors of Prisons and the Official Referees had also treated it as a satisfactory and efficient fire-proof construction; and he had himself found it to answer all his expectations. Whether this system or the French system should be considered preferable, one important point suggested itself in the present discussion, namely, that a very heavy responsibility would rest upon them and their successors, as architects, if they should disregard the fact, that there were systems known by which essentially fire-proof construction could be attained with very little extra expense; and it was their duty therefore to test these systems as severely as possible, and to employ one of them whenever they had the opportunity of doing so.

In reply to some inquiries Mr. WYATT added that some of the rooms in the Wiltshire Lunatic Asylum were 16 and 18 ft. by 24 ft.; the corridors being 150 ft. by 12 ft. The rigidity of the floors was remarkable, and the only doubt which ever arose in his mind had been caused by the appearance of a dark line on the ceiling immediately under each joist. This he had thought proceeded from some chemical action, but it had been entirely removed by the second coat of lime whiting.

Mr. PAPWORTH, Fellow, referred to the letter of Mr. Stevens of Derby, and inquired what amount of space in proportion to the whole superficies should be left around a plaster surface to allow of its expansion. His own experience suggested that an inch and a half on every side of a floor for every ten superficial feet would not be too much.

Mr. WYATT concurred in this opinion, and referred to a loft at the seat of Lord Cardigan in Northamptonshire, where the walls had bulged from the expansion of a plaster floor, although a space had been left originally to provide for this occurrence.

The Chairman, Mr. INMAN, V.P., stated that floors of plaster, sometimes mixed with coal ashes, were in general use in large mansions in the vicinity of London about eighty or hundred years ago. This was the case in some of the upper floors at Hampton Court Palace, where a layer of cockle-shells about two inches in thickness was also introduced in the floors, for the purpose of deadening sound.

Mr. BOULNOIS, Associate, observed, that in his experience of Fox and Barrett's system he had never found the ceilings give way, though he had employed plaster of Paris to guage them. From his remarks at a former meeting it might have been supposed that he disapproved of this system, but on the contrary, he thought it an admirable system, and by far the best mode of fire-proofing ever introduced. One great advantage which it possessed was that of economizing height,

which was a point of the greatest importance in London. With respect to Mr. Christopher's opinions as expressed in his pamphlet and those which he had now put forth, it should be remembered that that gentleman had in the first instance been led to publish his opinions without having had any actual practical experience of the system. This experience he had since had, and, as the meeting knew, it had proved unfortunate to him, inasmuch as he had been subjected to an action at law and other difficulties. He (Mr. BOULNOIS) therefore contended, that it was the duty of the patentees to ascertain and remove all such difficulties and defects as Mr. Christopher had met with in his practice, and not to allow the task to devolve on the architect employing their system of flooring.

Mr. H. H. BURNELL, Associate, contended that the French system presented greater economy of space than the English, and that the latter was very defective in respect to its giving no key for the ceiling.

Mr. BARRETT and Mr. WYATT expressed a contrary opinion on the latter point.

Mr. WYATT said he had no doubt that Mr. Christopher had written his pamphlet, "Notes of a Visit to Northwoods," with the most perfect conscientiousness, but after expressing himself so very strongly in favour of the system there used, and leading others to adopt it, he of all persons should have dealt as leniently as possible with any defects to which it might be liable. For himself he had found that the system fully justified the praise which Mr. Christopher *originally* bestowed upon it.

Mr. CHRISTOPHER, Fellow, reminded the members that at the commencement of his former remarks he had stated that he thought very highly of Messrs. Fox and Barrett's system. He had made minute inquiries of Dr. Fox, of his architect, and of the workmen at "Northwoods," and was led to express his opinion very strongly in the pamphlet quoted by Mr. Wyatt; and he still thought that for all practical purposes, this system from its economy was superior to any other for fire proof construction. He was therefore gratified to find that Mr. Wyatt, after his extensive experience, did not think the warm approval which he (Mr. Christopher) had formerly expressed in any respect overcharged. On reading the remarks which he had made at the last meeting, he confessed they appeared rather strong, and he should be sorry if they were to injure the patentee. Still, however, after four or five years experience, he had found imperfections in the system which had occasioned him much annoyance and loss, and he felt bound to caution his professional brethren on the subject. These it was true were comparatively *little* defects, and he did not wish to magnify them. He was not desirous to retract any of his former remarks as he believed them to be strictly correct, with the exception of an obvious error of £1. for fillets to a boarded floor in the estimate for a room of 20 ft. x 20 ft. Mr. Beck, in reply to an appeal from Mr. Barrett, had stated that he did not think it necessary to make any addition to "the footings of the walls" for this system; but what he (Mr. Christopher) considered necessary was to increase the "foundations," a distinction recognized in the Building Act and by other authorities. It was essential to be very careful with the foundations where this system was employed, especially if a rigid material like Portland cement were to be used for the floors. Hoop-iron bonding he considered necessary, as in the patent system there was no provision for a tie, and no substitute for the timber plates used in ordinary construction. Again, the play of the iron joists before the concrete was filled in was objectionable, and liable to loosen the green brick work; and it had obliged him to take out the arches over openings and substitute stout iron lintels. He had not ventured to offer the remarks he had made in any case from the result of *one or two failures only*, and in all cases first rate builders had been employed by him, and no expense or pains had been spared. On the subject of cost he had confined himself to *Mr. Barrett's estimates*, published in the Transactions, and the question was, are those correct and not what the Wilts asylum may have cost some years ago, when

iron was at less than half its present price. With reference to the question of cost generally, he (Mr. Christopher) should not have entered upon the subject, if Mr. Barrett had not endeavoured to shew that his fire-proof floors could *now* be constructed cheaper than ordinary floors of the best kind. Mr. Barrett had made a deduction of *one half* the cost of the iron from his estimate for "excess of strength," and this deduction was one which he (Mr. Christopher) thought quite unwarranted; because if the strength of the floors were proportionably diminished, they would not be safe.

MR. WYATT. What Mr. Barrett said was that he would not like to take the responsibility of the lightness of the French mode of construction, but that a great reduction in his standard of strength might safely be made.

MR. CHRISTOPHER repeated that Mr. Barrett's estimates were incorrect; that when he went into the matter with that gentleman they had found it impossible to reduce the price to that of an ordinary timber floor, and that the additions made by him to Mr. Barrett's estimate for cutting and trimming joists, the use of the license, &c. were fair and moderate additions. Carefully detailed accounts had been kept of the recent buildings erected under his direction to test the result, and from these he had quoted, but Mr. Wyatt admitted he had not gone into the estimates. Another point that deserved consideration was that many persons would desire a wooden floor upon the concrete foundation; and in that case a considerable extra cost was incurred, and some of the advantages were lost, as the building was less fire-proof, the floor afforded a harbour for vermin, and was liable to rot, besides which there was a loss of space. With respect to the roofing it should be observed, that at Northwoods the concrete roofs were all finished with tarred paper and sand, which had been found successful. The Building Act however precluded the use of these materials in London, and therefore cement *alone* was used, which had failed, as before described. Now although this question had been discussed chiefly with reference to *floors*, it appeared to him that the *roof* was the most important consideration with respect to fire-proofing, as many buildings had been ignited through the roof from fires in adjacent buildings, and certainly if *floors* could be constructed on this principle at the same cost as ordinary floors, *roofs* could be constructed at less than half the ordinary cost.

MR. BARRETT wished first to offer a few remarks in reference to some observations made by Mr. Tite at a former meeting. That gentleman stated that the system of fire-proof construction, which Mr. Barrett had explained, was very similar to one which he (Mr. Tite) had himself used twenty-eight years ago. There were, however, important differences, both in the principle and the cost. In the plan referred to by Mr. Tite, the stone landings were merely a modification of the iron girder and brick arch system; they were a dead weight upon the girders, and not an element of strength; while in his own plan the union and combination of the different materials produced a great increase of strength and rigidity, and at a small expense. In the one case these important qualities were derived from the *iron*,—a costly material; and in the other from the *concrete*, a very inexpensive one. But the real question was, not whether any of these materials had been previously used in the construction of floors, it was rather whether they had been so arranged and combined as to produce a satisfactory floor of incombustible materials at a cost little, if at all exceeding, that of the ordinary timber construction; whether in fact it could be said before the introduction of this system (as it had been said by Mr. Wyatt) that a large and important public building had been constructed on a fire-proof principle without incurring one shilling additional expense. Reckoning the cost of the 4-inch and 6-inch self-faced stone landings, at prices furnished to him by a contractor, viz.—1*s.* 6*d.* and 2*s.* per foot, and assuming the iron to be no heavier than in his own case, the actual cost would be more than double that of his construction; thus—

ROOM 12 × 12.

	£.	s.	d.
144 ft.—4 in. Landing—at 1s. 6d.....	10	16	0
Iron Work as at page 47	3	15	8
Facing Surface and forming Cement Ceiling, 6d. per ft.	3	12	0
	£18	3	8
Instead of	7	14	10
Difference	£10	8	10

ROOM 20 × 20.

	£.	s.	d.
400 ft.—6 in. Landing—at 2s.	40	0	0
Iron Work as at page 47	21	4	3
Facing Surface, &c., 6d. per ft.	10	0	0
	£71	4	3
Instead of	32	4	3
Difference	£39	0	0

He thought, therefore, there was sufficient reason for such a system never having come into general use. Mr. Tite had also referred to the decoration of ceilings, but he could not imagine any difficulty whatever to exist on this head, and if none was found in erecting a residence for the highest personage in the realm, there was little probability of its occurring elsewhere. Certainly any kind of decoration that could be combined with the girder and arch system could, with at least equal facility, be applied to his construction: but upon this point any member present might satisfy himself by inspecting the New Offices and Station of the Brighton Railway Company at London Bridge, where the system was carried out on a very extensive scale, some of the bearings exceeding thirty-five feet, and where many of the ceilings were of a highly decorated character. Mr. Tite had also spoken of the possibility of the concrete yielding under the action of fire if it were formed with flints. This material was, however, never used for the purpose; the concrete being made of fine gravel or ballast, broken brick or tile, burnt earth, and lime. Upon this point he thought an important consideration had been overlooked, viz.—the fact that in warehouses where large fires occurred, they were mainly owing to the circumstance that the timber floors themselves afforded both the fuel and a ready supply of air to support and extend the fire, which would burn but slowly till it had consumed a portion of the floor, so as to obtain a supply of air. The case, however, was very different, if instead of a floor being of a highly inflammable nature, it was formed of a solid mass of incombustible materials twelve inches thick, by which the supply both of fuel and of air would be cut off. The fire, generating an atmosphere which will not support combustion, would under such circumstances probably burn itself out. Even supposing any intense degree of heat to be generated, before it could act injuriously on concrete it was probable that it would quite destroy a brick arch, either by disintegration or by the arch's own expansion; and the consequences which might result from the failure of a single arch in a building were fearfully exemplified in the fall of a cotton mill at Oldham some years ago, the replacing of one of the arches which had settled having led to the breaking of the iron beams from the lateral thrust of the adjoining arches, and the sudden and instantaneous destruction of the entire building—a calamity which could never possibly happen with his plan of construction.

With regard to the objections raised by Mr. Christopher at the last meeting, there could be no question that Portland cement should never have been applied as a finished covering for roofs, but that gentleman had not stated that he had himself preferred it and introduced it. Indeed he was the first to erect a roof upon the principle since the completion of the original building, the roofs of which he, “after careful inspection,” greatly admired, and described in 1848 as being “marvellously simple and inexpensive while efficacious, being perfectly water-proof, and much more impervious to the variations of temperature than the usual roofs;—those built eight years since being perfect, and the ceilings under them without a stain.”

Mr. Christopher had adhered strictly to the construction of these roofs, except in that part which in his case had failed, viz., the finished covering, which he had formed of Portland cement, instead of tarred paper and sand, the use of which was said to be prohibited by the Metropolitan Buildings Act. It had been intimated by that gentleman, that the failure of the cement covering might have been occasioned by the expansion of the concrete; but the fact of its remaining sound for twelve months, shews that it could not have arisen from that cause. Concrete does unquestionably expand *in setting*, but not afterwards. Mr. Christopher had moreover told him, that the experience of a brother architect showed that when Portland cement was laid on brick arches, there was the same uncertainty as to the result. It was however, admitted, that metallic lava answered, and he might add, that asphalte, tiles in cement, and slates in cement, had also been applied with perfect success.

As a finished surface for floors, Portland cement had answered perfectly in several instances, but it was a very uncertain material, and in those cases where the floors were not to be carpeted or covered, or where a slight superficial defect was of consequence, it would be better to use a cement of another description, such as Keene's, which had been substituted for Portland in a large building lately erected by Mr. Clarke—the Metropolitan Convalescent Asylum—at an additional cost of only £30., and it certainly looked much better.

With reference to the ceilings, and the alleged want of a good key having occasioned several falls; Mr. Barrett first observed, that if this really were a radical defect in the system, it admitted of a very simple remedy, for nothing could be easier than to attach the ordinary lath and plaster ceiling by means of light fillets placed parallel with the joists. So far, however, from the key being defective, he had been assured by practical men, plasterers, and foremen, that the key was a much better one than in the ordinary construction, from the greater strength of the laths. He had communicated with several members of the profession who had used the system largely, upon this and other objections stated by Mr. Christopher; amongst them were Mr. Wyatt, who had had from 1,400 to 1,500 squares of flooring constructed; Mr. Rhode Hawkins, 530 squares; Mr. Brandon, 900 squares; Mr. Clarke, 400 squares; Mr. Salvin, 500 squares; Mr. Holland, 1,200 squares; and Mr. Piper, 1,400 squares; in the aggregate several thousand squares; and it was remarkable that out of so large a quantity no instance should have occurred of a ceiling falling. In Mr. Christopher's case, he believed it to have arisen from his having kept coke fires in the middle of the room, *upon the concrete, for several weeks in succession*, to dry the plastering of the walls; as the portion of ceiling which fell was directly under one of these fires. The report of a Committee of Magistrates who visited Northwoods to see the original building, was to this effect.

“Our attention was first directed to the very beautiful and perfect appearance of the ceilings of the rooms, (after fourteen years' duration), which are in fact a part of the fire-proof floor; these ceilings, even after so long a period, presented a perfectly plane and level surface, and were quite free from cracks;” and Mr. Christopher's own report of this building was “the ceilings are finished and appear as usual, but equalling the best, as they remain for fifteen years without a crack!” Mr. Christopher had also stated in reference to the ceilings of the building, the roof covering of which had failed, “the ceilings were everywhere entirely free from cracks, and decidedly more perfect than in ordinary buildings.”

He begged permission to read the following letters from some of the gentlemen he had referred to.

FROM MR. JOSEPH CLARKE, FELLOW:—

I feel I ought to add my testimony to what I consider the full success of your patent, which I have adopted in several important buildings for some years past. I must say that I have not met with a single failure, and certainly on the points of objection which I hear have been raised:—

1st. That the adoption of the system involves greater expense in Foundations. These I have never considered it necessary to increase in the least, in fact in one work I am now carrying out on your principle, I even reduced the depth, and on a site of which I had a little apprehension.

From the confidence I have in the perfectly horizontal bond and tie given to the Walls, I am satisfied that in the Oxford and the Gloucester and Bristol Training Institutions, (both stone buildings) I derived much greater advantage than if I had adopted the common mode of Timber floors.

2ndly. As regards a greater chance of smoky chimnies, I have been singularly fortunate in all the buildings thus constructed, and I can refer you to the Convalescent Hospital at Walton, where not a single chimney smokes out of nearly fifty, which have been in operation for months, even before the building was complete, that it might be ready for the patients.

As to the 3rd objection, that the ceilings are apt to fall, I have carefully examined many hundred squares, executed on your principle, and I do not find the slightest tendency of the kind.

I am so fully convinced of the value of your invention that I am prepared to recommend it, particularly since the adoption of wrought iron, for every class of building.

FROM MR. RHODE HAWKINS:—

There are three points on which you ask my opinion of the fire-proof floors used at the new buildings at Guy's Hospital.

1st. With regard to the necessity of using more solid foundations in consequence of the increased weight of the floors. I have to say that though your floors are heavy as compared with ordinary wood floors, yet as the weight of the floor is after all but a small portion of the whole weight which a foundation has to carry, I do not think that the extra weight should be considered for a moment; as to the necessity of additional ties to the walls, if the girders and joists are of sufficient strength, the weight will be conveyed directly on to the walls, and resolve itself into a mere crushing force, and ordinary brick walls are competent to carry five or ten times the weight which is generally put upon them. With regard to the ceilings, I have only to say that at Guy's Hospital I know of no ceiling having given way, the key seems to me to be a very strong one, and I see no reason to apprehend any accident of the sort. The ceilings have been finished nearly a year and a half, and are perfectly good now. With regard to the floors causing smoky chimnies I have little to say, as I have not tried the plan in an ordinary dwelling-house. At Guy's Hospital the smoke is carried in a long smoke tube into a lofty shaft where there is a considerable draught, and none of the chimnies smoke; but I must add, that I think that where it is necessary to supply air to the fire-places, it should be done as a system, and not left to the chances of drawing the air through the floors, and with it a large quantity of dust and dirt.

FROM MR. R. W. ARMSTRONG:—

In reply to your query whether I deemed it necessary to go to extra expense with the foundations of the buildings in which I introduced your patent fire-proof flooring, beyond that which I would have done had I used timber floors; I beg to say the buildings in which I used your system of flooring, being for factory purposes, I considered it expedient to provide foundations sufficient for any emergency, and therefore did not allow the fact of the floors being heavier than timber floors to influence me in any way. As to the broad question for buildings in general, much must depend on the number of floors and the proportion of bearing points to the void or area to be supported on those points, but I think few would venture to erect buildings with timber floors on foundations that would not be equal to the sustaining of the additional weight of floors constructed on your principle, as in

my opinion it would be narrowing the point far beyond the limits of practical application. I have not in any instance found it necessary to introduce any additional "*ties*" for the floors than that given by the joists.

FROM MR. THOMAS PIPER,

The result of my experience with floors constructed on your principle, is that no additional foundations or ties are required beyond what would be requisite and necessary for good building on any principle. That the ceilings are not more liable to fall than ceilings on laths in the ordinary way, indeed I cannot charge my memory with any instance of a ceiling falling in any of the works carried out on your plan. As to smoky chimnies they are no novelty unhappily, and though the tendency of the greater accuracy of all building operations is unquestionably to limit the supply of air and so retard the escape of smoke, I have noticed no difference between what occurs with your floors and a thoroughly good wood floor of the ordinary construction pugged in the usual way.

Mr. BRANDON states that "he has never had cause to increase the strength of foundations, or the walls, or ties in the walls. He has never known any defect whatever in the ceilings, except an occasional very minute crack, such as might be found in those of the ordinary construction, perhaps 10 or 12 such in a building, containing 800 squares, and he has never known an instance of chimnies smoking."

With regard to the time required for the floors to dry, it depended on the season, but they were always dry as soon as the walls and plastering made it safe or prudent to occupy the building; at some floors lately constructed at Windsor Castle, the rooms were occupied in six weeks from the receipt of the joists. The house in the Adelphi referred to by Mr. Christopher, was begun in April 1850, and though it was a large building containing nearly 30 rooms, and lying close to the river, it was occupied in March 1851, although there had been several delays. The peculiarities of the other building he referred to should have been stated: it was in a hollow, with lofty buildings at the back, two high flank walls, and a narrow mews in front; there was in fact no possibility of establishing a current of air through it, even if its construction had admitted; but the fact was, that out of 42 rooms, only 18 had fire-places, and the 24 rooms which were without fire-places were all so constructed that there could be no current of air through them, and 12 of them were lighted only from the staircase. These circumstances were quite sufficient to account for its taking a longer time than usual to dry.

With respect to ventilation and artificial warming, it was quite true that facilities were afforded by the system, if those adopting it would avail themselves of them; but that they were more *necessary* than in the common method was not the fact; and as regarded loss of draught to fires by the floors not affording a supply of air, it struck him that this was rather an advantage than otherwise, as cold draughts to the feet and legs were always objectionable; indeed Mr. Christopher himself had been one of the first to point out this as an advantage of the system. Certainly this had never been complained of by any one else, and numerous enquiries had satisfied him that the complaint had no real existence. In speaking of Northwoods, Mr. Christopher had stated that "regarded simply as a residence, it was most comfortable." And so satisfied were the Metropolitan Association for Improving the Dwellings of the Working Classes with this system of construction, in one of their buildings containing 186 rooms, that the Secretary had written as follows:—

FROM MR. GATLIFF, Secretary of the Metropolitan Association for Improving the Dwellings of the Industrious Classes.

“In reply to your inquiry as to the success of your fire-proof flooring in the 186 rooms in which it was used by the above Association, I beg to say that an accident not having occurred to test its qualities in that particular, I cannot say more than that from the opinion I have formed, I should recommend its adoption in between 3 and 400 more rooms about to be constructed by this Association in Guy Street, in the Borough of Southwark, and more especially from its being *sound*-proof, which we find a great inconvenience from, in about the same number of rooms in the Old St. Pancras Road.”

It was stated in the Ninth Report of the Directors of this Association, that in the family dwellings above referred to, providing accommodation for 60 families, not a single death had occurred in the course of the preceding year, out of an average population of 300; a circumstance which may be presumed to indicate that the system is not without its advantages as regards the health and comfort of the occupants: and besides the circumstance of the building being fire-proof, the Association has found that on certain other points this system of construction possesses advantages which are of much importance in buildings of this character, being “very instrumental in preventing the travelling of sound from floor to floor, of vermin, of offensive smells, and of the filtration of water in case of accident from the overflowing of cisterns or otherwise.” These floors had a boarded finished surface.

These facts he thought rather indicated that the system was advantageous as regarded the health of the occupants of the buildings, and this could not be said of smoky and ill-ventilated dwellings.

The alleged necessity for better foundations and ties, was perhaps best met by the letters already quoted: they were not provided in the five-story building mentioned at the last meeting, nor at the large Hotel at Carlisle, lately erected by Mr. Salvin; and he referred particularly to these two works, because the plans of both were originally prepared for timber floors, and no alterations were made by the introduction of the fire proof system; nor could he find that they had been increased in any instance. In the original building at Northwoods, and many others, no ties whatever were provided.

As to the License, although the charge was rather for the information supplied, yet it could easily be shewn that it was soon repaid by the saving in the fire-insurance. This saving on the building in the Adelphi was £4. 10s. per annum, repaying the charge in less than seven years, and after that time becoming an annual saving to that extent in perpetuity.

The charge for cutting and trimming joists was certainly an error, as the castings were not adapted for trimming; the building had been altered during its progress, and some little expense might possibly have been incurred on that ground. The painting of the joists was by no means necessary.

Upon the question of cost, Mr. Christopher had stated that the estimates were not to be depended on, and he had given a calculation of his own, making additions, to every one of which he, Mr. Barrett, altogether demurred, and for which he had shewn there was no foundation, as they had not been incurred by any other architects. The figures he had originally given in page 46, spoke for themselves, and showed the cost with the iron of the strength he usually employed, and also of that used in Paris. He did not however recommend a reduction to their standard, but had stated that some reduction might very safely be made, and he had actually had floors constructed with joists 25 per cent less in strength than those which formed the basis of his calculations, and with perfectly satisfactory results. He had no doubt whatever that the joists he used were much in excess in point of strength, and he was confirmed in this view by the fact that those of extra strength described in Mr. Burnell’s table as employed at the Louvre (see page 54) were not so strong as those he had employed

for ordinary dwelling-houses. Mr. Christopher's conclusions were therefore altogether erroneous as to the possibility of reducing the strength, and the cost of the iron work fixed, Mr. Barrett had actually reckoned at 10s. per ton more than the price at which it had been lately undertaken. The cost of the roof, the cement covering of which had failed, was according to Mr. Christopher's own statements as follows :—

“The roof with ceilings and cement surface had cost £74; While an ordinary slated roof with ceiling, would have cost £232; and a lead roof would have cost £300”. If the cost of an additional covering of metallic lava £40 were added to the cost of the roof with a cement surface £74, the total cost would be £114, against £232, shewing a saving of £118 or £3 per square on the quantity of flooring in the building.

Mr. Christopher had stated that the object of this discussion was to ascertain the truth, but this could only be done by the *whole* truth being stated, and that Mr. Barrett must contend had not been done in the several objections he had raised.

Mr. SCOLES, Hon. Sec. inquired whether concrete had been really found to be fire-proof, and stated that a large mass which he had put into an ordinary fire had crumbled entirely in less than five minutes.

Mr. BARRETT argued that this was not a conclusive test, indeed the plaster slabs mentioned by Mr. Wyatt at a previous meeting would have been destroyed under similar circumstances. It was in evidence that his concrete floors would be protected by the plaster ceiling, and where injury had arisen it was only by the long continued action of fires made for drying the plastering of the walls.

Mr. PAPWORTH observed that in his opinion no really fire-proof floor or roof had yet been mentioned. An Obelisk erected in 1776 on Putney Heath, by order of the Corporation of London, commemorated the satisfaction felt by committees of that body with experiments made in 1776, described in a pamphlet, printed in 1785, and entitled “an account of the invention and use of fire-plates for the security of buildings and ships against fire.” The author, Mr. David Hartley, was Member of Parliament for Hull. A reprint with additions by his nephew in 1834, stated that “resistance to every possible degree of fire, such as in distillers’ shops, or turpentine warehouses, may be accomplished by applying the fireplates above and below the timbers with dry sand or rubbish between them: in experiments repeatedly tried with this double application, the room was filled from the floor to the ceiling with faggots and pitch and tar. As to common dwelling houses; when the single application of the fireplates was used in the experimental house, where also air bricks were provided to the floors, the trials were continued from day to day to the same part of the ceiling and timbers of the house a great number of times after the plasterwork was burnt down and destroyed, but the timbers could never be set fire to, so as to burn of themselves, nor could the fire ever spread sideways; as long as the burning faggots were applied to the timbers, they were charred perhaps to the depth of an inch of their substance; but the fireplates over them acted as an unconquerable extinguisher, preventing them from taking fire and burning of themselves.” Rolled copper-plates are specified as well as those of painted iron; tinned or galvanized iron or zinc would be equally applicable. In 1774, the sum of £2500 was voted to the inventor by the House of Commons, and in 1777, the patent was extended for thirty-one years from that time. The experiments he made however shewed that the only way to check a fire was to prevent the access of air; for flame would inevitably calcine such materials as concrete and plaster. The various systems of iron flooring which had been discussed were valuable as precautionary measures, and worthy of attention, and Mr. Papworth had, therefore, much pleasure in moving the thanks of the meeting to Mr. Burnell and Mr. Barrett for their communications.

Mr. H. H. BURNELL explained, that although violent and long continued heat would destroy the French floors, yet the earthenware pots would be a great impediment to the spread of any moderate fire.

Mr. TARRING, Fellow said, that in the West of England where concrete or lime ash floors were much used in common houses, the concrete failed or became rotten in the parts nearest to the fire-place, but when formed of lime mixed with sand and hair, it would last longer in that position than when composed of gravel. Plaster ceilings would resist fire, but cement would not, as that material soon yielded to heat. In old malt houses in the West of England, with concrete floors 5 to 6 inches in thickness, he had seen the walls though built of stone 2 ft. 6 in. to 3 feet thick, bulged out three to four inches on each side by the expansion of the concrete.

The CHAIRMAN reminded the meeting of the different effect which fire would produce on timber and on metal, from the former being a nonconductor and the latter a conductor of heat. Such effect should be guarded against in a fire-proof construction, so that the metal might not conduct the heat to the wood. Experience had shewn that in the event of a fire breaking out, the grand object was to get it under within the first quarter of an hour, and to aid in accomplishing this, the Building Act had wisely restricted the cubical contents of each division to be separated by walls in warehouses and similar buildings.

At the suggestion of the Chairman, the vote of thanks was extended to all the Foreign and English gentlemen who had furnished remarks upon the subject, and the meeting then adjourned.

NOTE.—Mr. Christopher thinks that the apparent difference in the testimony borne by Mr. Wyatt and by himself in reference to Fox and Barrett's patent may probably be explained by the fact that Mr. Christopher's experience has been almost wholly confined to London, while Mr. Wyatt's appears to have been restricted to the country. In London the frequently disturbed state of the soil and the height of the buildings require *extra foundations*, while the numerous windows, confined to the backs and fronts with small piers of separation, and many difficulties of construction, demand *extra iron bonds*. The long unpierced party walls, the contracted areas at the backs of the houses, and the want of sun in front, retard the drying, while the same causes, coupled with the smallness of the rooms in chambers and dwelling-houses, compared with the large dormitories and corridors in Asylums will, in some measure, explain why the loss of draught to the fires from the absence of hollow floors and partitions is so felt in these solid houses. Mr. Christopher thinks that none of these difficulties would occur at Northwoods, situated in the midst of a park, or to the buildings which Mr. Wyatt, Mr. Clark and others, have superintended in the country. Mr. Christopher wishes to state that neither pains nor expense were spared to secure the most perfect execution of the buildings carried up under his superintendence in respect to materials and workmanship.

A BRIEF ACCOUNT OF THE PALACES OF THE LOUVRE AND TUILERIES, PARIS,
FROM THEIR FIRST ERECTION TO THE PRESENT TIME; WITH A GENERAL
DESCRIPTION OF VARIOUS PROJECTS FOR THEIR COMPLETION AND
JUNCTION, PARTICULARLY THE ONE ACCORDING TO THE DESIGNS OF THE
LATE MONSIEUR VISCONTI, HONORARY AND CORRESPONDING MEMBER,
NOW IN COURSE OF ERECTION.

By T. L. DONALDSON, Honorary Secretary for Foreign Correspondence.

Read at the Ordinary General Meeting of the Royal Institute of British Architects, 6th March, 1854.

FIRST EPOCH, OR THE FEUDAL.

A MAP, supposed to be of the period of Dagobert the 1st., the authenticity of which, however, is much contested, would lead to the supposition, that the Louvre already existed as a hunting palace at that time—that is, A.D. 633. But the first precise mention of the Louvre would appear to be under Louis le Gros, 1108, who received the oaths of fidelity to him at the Louvre, at that time regarded as an important fortress. It was placed just outside the town, on the bank of the Seine, where its position commanded the approach to Paris on this side, and defended the city from the attacks on this quarter, the main road passing inside its exterior defences.

Philip Augustus (1180-1223) rebuilt and made considerable additions to it. He constructed the great Donjon tower in the centre, as a state prison, and for the safety of his treasure, 96 ft. high and 48 ft. in diameter, the walls being 13 ft. thick at bottom and 12 ft. at top, and surrounded by a ditch.

Charles V. (1370-80) was the first king after Philip Augustus, who embellished the Louvre, hitherto more distinguished as a strong fortress than a kingly residence attractive by the graces of art and embellishments of taste. The reign of this king was most favourable for architecture and sculpture, as he was fond of the magnificence of the kingly state, and loved the arts as adding to its value and conferring true beauty. He enlarged and adorned many royal residences, and erected many castles, as those of Creil and of the Bastille. He added considerably to Vincennes. Mons. De Clarac gives a plan of the chateau of the Louvre, founded on the works of Sauval, who wrote at the time of Louis XIV, and whose book is intitled “*Œuvres Royales* ;” and although Sauval has no plan, he is so minutely particularly in his description of each portion of the castle and dependencies as to afford authority for every part. The enclosure of the Louvre, comprehending the fosses, but exclusive of the outer works, was nearly square, measuring 360 ft. towards the river, and 342 ft. in the other direction. At the angle of the outworks next Paris, and close to the Seine, there was a lofty tower, opposite to a corresponding one, the Tour de Nesle, on the other side of the river, and which forms a prominent object in the old prints of Paris by Silvestre and others, a line of wall fortified by towers afforded security from attack on the side next the river, and formed an enclosed space outside the chateau. This angle tower was possibly the Tour de Vindal of those times, and, as a leading position, probably had under it the sluice gates, which regulated the quantity of water in the fosses secure from any attack, which might leave the ditches dry. Attached to it was the Gate of Paris, flanked by circular towers, and a corresponding one, the Porte Neuve, was at the other end of the court.

Near the Gate of Paris is an entrance into one of the “*basse-cours*” of the chateau, leading to the gate of the tête du pont, close to the central towers of the façade facing the river. Here, also, was an entrance to the gardens laid out in beds, with a trellis at the further end, and immediately in connexion

with the dependencies. It will be remarked that this gate at the tête du pont has a lateral entrance, not immediately fronting the entrance towers of the castle, a precaution observable in other castles, as affording greater security to the approaches.

The fosses were not all of equal width, varying from 32 ft. to 48 ft. wide, and about 20 ft. deep. On the side next Paris were the offices of the chateau outside the fosse, and containing those dependencies required for the service of the Royal Family. Towards the north and outside the fosse was the "*grand jardin*," or grand park, and, being outside the city, it produced abundance of vegetables, fruits, and flowers. On the west side, and near its south-west angle, was the arsenal of the artillery establishment, with courts and buildings necessary for all the works, as the foundry, stores, and workshops, &c. connected with that arm of military warfare; and attached to it was an ample residence and garden for the master of the artillery.

Near the street of the Froidmanteau there was, ever since 1333, the menagerie, a usual appendage to royal residences of that period, and which also remained in the Tower of London up to within our own time. Here were kept rare animals, brought at a great expence from foreign lands, which served as a curious show, and sometimes afforded sport by being made to fight each other. Charles V. had one in his Hotel de S. Paul, a record of which is retained in the name of a street, Rue des Lions, which was carried through the spot formerly occupied by the menageries: so frequent is it that names of streets hand down traditionally the former purposes for which certain sites once served. Having thus generally noticed the arrangements connected with the fortifications and the domestic arrangements of the basse cour, gardens, and arsenal, &c., we shall proceed to examine the body of the castle itself.

The central court was about 206 ft. × 197 ft. square, entirely surrounded by buildings, with the central Donjon in the middle. Raimond du Temple was the master of the works, or architect to Charles V., and executed the various additions and alterations which were made at this time, not only to the chateau of the Louvre, but also to that of Vincennes. The several towers had each a specific name, particularly those at the angles, which were called respectively next S. Nicholas, next the Seine, next the great garden, according to their position, and are represented in various views of remote periods as still existing, as in those of Quesnel, Sylvestre, &c., in various manuscripts as late as the 16th century.

Each entrance was flanked by two towers, but that towards the Seine being the principal one, was strengthened by being of larger dimensions. Over the centre was apparently the clock tower; probably the clock was placed there by Charles V. about 1370, when public clocks were first generally introduced in Paris, for doubtless that enlightened prince, the first to patronize any novel invention, had one placed at the Palace by Henri de Vie.

On the west side there would appear to have been an entrance equally important with that next the river, flanked by two towers, with a drawbridge and two turrets, forming, as it were, a tête du pont; and there is an ample open court or space outside the precincts of the castle, next the Rue Froidinanteau, affording access to the artillery arsenal, and the menagerie already mentioned.

On the north side there was only a secondary class of exit for the purpose of reaching the great garden over a light bridge.

On the east side is a central secondary entrance, flanked on the outside, and leading by a drawbridge to the domestic offices, an arrangement apparently founded on the authority of Sauval's description.

The central Donjon Tower communicates with the buildings, which surround the court by a bridge and a narrow gallery leading to a grand circular staircase (*la grande vis*), affording access to the upper floors. It was in a circular tower, 61½ ft. high, with a terrace on the top. This staircase

which existed up to the time of Louis XIII., is mentioned by Sauval as having been a chef d'œuvre of Raimond du Temple, the architect and sculptor, both in point of construction and decoration. There were ten large statues on pedestals; the mouldings were richly carved.

We will now consider the arrangement of the apartments, on the authority of Sauval, who appears, according to the registry of the "*Œuvres Royaux*," to have followed the order of the several rooms and halls. The apartments of reception and ceremony were on the west side, the apartments of the King and Queen to the south, next the river. Those of the Queen on the east side of the principal entrance consisted of two large chambers, cabinets, and garderobes, an oratory, and bath. On the western side of the entrance was a noble hall, called "*Salle Neuve de la Reine*," 54 ft. long $\times$ 27 wide; and at one end of it the tower of the Library, to which there was access by a small circular staircase in the thickness of the wall from a vestibule opening immediately into the court. Although dignified with the name of Library, the apartment destined to receive books was not necessarily large in extent; for, before the invention of printing, as all books were, of course, in manuscript, the amplest fortune could not boast a very numerous collection, frequently more used by the chaplain than the owner. It is a question whether Charles V., on the death of his father, John, had ten or twenty volumes. About one hundred years before printing was discovered, nine hundred volumes was a very considerable number. Charles V. had collected them from all countries; he sought those most beautifully written and emblazoned, and had them richly bound, and he allowed any one the privilege to consult them who was distinguished by his learning, or known to be studious; and for this purpose the library was open by day, and in the evening. It is a curious circumstance, that forty-nine years after the death of Charles V.—that is, in 1429—the Duke of Bedford, then Regent of the kingdom, purchased the collection of works, then only 853 in number, which were sold for £2,323. of our present money, and sent over to England.*

It may be well imagined that this Royal residence was embellished with becoming decorations, and that the furniture, fittings-up, and other accompaniments were of corresponding beauty and magnificence. But after the time of Charles V. (1380) it was much neglected; Charles VI. only added to the fortifications, and the immediately succeeding monarchs no longer occupied it as their residence.

SECOND EPOCH, OR THE RENAISSANCE.

We now enter upon the second epoch in the history of the Louvre, which had hitherto served as a fortress and a castle.

About 140 years after the death of Charles V. François I. mounted the throne; he was a monarch, who deeply felt the charms of art, appreciated their value, and by his enlightened taste created a school, which has held ever since a first rank in Europe. He turned his attention to the embellishment of Paris, and while the Popes and Medeci were promoting the fine arts in Italy, he encouraged them in France, and by his favour and liberality attracted the Italian artists to France, where they found an honourable reception.

François I. perceived at once the vast changes, which the feudal Castle of the Louvre required in order to make it accord with the wants of a more refined age. He resolved to destroy the greater portion, and to rebuild it on a new plan. In fact, it is generally more easy and judicious, and often also less expensive, to construct an edifice altogether anew rather than to make ancient constructions accord with new arrangements.

* On this matter I am kindly referred by Sir Henry Ellis to the following work—*Bibliothèque Prototypographique ou Bibliothèques des fils du Roi Jean, Charles V, Jean de Barri, Philippe de Bourgogne, et les siens. De l'Imprimerie de Crapelet* 4to. Paris, 1830. The name of J. Barrois is attached to the Preface.

D'Argenville is of opinion that the new works were commenced about 1540; and it is supposed that Pierre Lescot, then about 30 years old, had charge of the project. But during the reign of that monarch, it would seem, that the operations rather consisted in pulling down the old building, and in arranging a noble hall in it, since known, from its decoration, as the *Salle des Caryatides*. Lescot continued his operations under Henri II., François II., Charles IX., and Henri III., and called in aid the rare talents of Jean Goujon and Paul Ponce to execute the sculptures. Whether François I. contemplated the great enlargement, which the Louvre subsequently received, cannot be ascertained, as the plans of the architect have not been preserved, and Lescot only operated upon the south and west sides of the old chateau, which were only half as long as they are at present. He gave the elevations the renaissance character of decoration, converting the circular angle towers into simple flat projections. He was influenced by the feelings which directed the architects of the mediæval period. The outside of their chateaux and palaces were simple and severe, defying attack; but they rendered their interior courts more rich in ornamental detail, as being secure from danger; the windows were more spacious as offering no facilities to any enemy in that position, and they sought to give a more cheerful character, where the sombre appearance of the building would have offered no advantages. So Lescot made his exterior plain in feature, but the interior of the court revels in excess of ornament, profusely lavished. Columns and pilasters, richly carved cornices, pediments, imposts and pancls, statues, bas reliefs and sculptures throughout, produce a dazzling brilliancy, which bewilders the attention and evinces a great want of repose. But Lescot was a great master in his art, and for his noble conceptions was made Canon of the Cathedral of Paris and Abbot of Clagny near Versailles, thus uniting the crozier to the T square. Serlio, who was in France at this period, is supposed to have been occupied upon the Louvre, and to have made a design for it; but Lescot's was preferred, even, it is said, with the concurrence of the frank Italian, who acknowledged, as it is affirmed, the superiority of his rival's design. Serlio died in 1552, passing the latter years of his life at Lyons and Fontainebleau, highly respected for his talent, but tormented by the gout and miserably poor. Parts of the chateau of Fontainebleau are attributed to him.

Catherine de Medici, widow of Henri, undertook a work about 1564, which hereafter much influenced all operations connected with the Louvre, and of which it was henceforth to form an integral part. This Queen determined to erect a country palace just outside of Paris, but not too remote from the Louvre, in a plain where there were certain tile kilns, and which gave the name to this palace of the kings and emperors of France—I mean the Tuileries. She called in the taste and skill of Philibert de l'Orme, already advantageously known under François I. for works at Fontainebleau, Meudon, Villers Cotterets, in the tombs of the Vallois, and for the charming gem, the chateau d'Anet, which he built for Diane de Poitiers. He associated with him Jean Bullant, a man of no mean reputation, and they together designed a magnificent project, of which they executed only a fragment, as it were, such as the banqueting house of Whitehall is to the grandiose project for the Palace of Charles I., as fully designed by Inigo Jones.

The complete plan for the Palace of the Tuileries of Catherine de Medici consisted of a parrallelogram 895 ft. $\times$ 555 ft., with three courts, the central one being much larger than the others, as according to the plan in Ducenean and Durand's paralel it measures 377 ft. $\times$ 295 ft., the two smaller ones each as long as the large court though less wide. The rooms and galleries appear to be from (10 m. to 12 m.) 33 ft. to 40 ft. wide, and some of the galleries 426 ft. long $\times$ 36 ft. wide, with noble staircases, chapels and other palatial arrangements on the most magnificent scale. One front only, however, was executed of this stupendous project, the rest, had it been carried into effect, would have occupied a considerable portion, at least one-third, of the present court of the Carousel. This gigantic

conception, even in its reduced part, was incomplete when Delorme died, in 1570, and never inhabited by the Dowager Queen, whose capricious taste was taken up with the erection of another palace upon the site of the present "Halle au bled," first called the Hotel de la Reine and afterwards the Hotel de Poisson, the expense of which absorbed the funds intended for the Tuileries.

It was during the progress of these works that an addition was made to the Louvre, by bringing out from its S. W. angle the gallery which runs down towards the Seine. It was only one story high, covered by a terrace, like the projecting wings of the Palazzo Pitti, of Florence, which possibly gave rise to the idea in the mind of the Queen, a Florentine by birth.

At this period then the Louvre and Tuileries present the following aspect. We find the W. and S. sides of the chateau as they were modernised by Lescot, under François I. and Henry II.; but the other sides of the chateau presented still the aspect of a fortress or prison, although many of its towers had been taken down. The projecting gallery struck out from the S. W. corner towards the Seine, and some imagine that possibly it was continued for a certain length along the side of the river. In the distance was the fragment of the Tuileries contemplated by Catherine de Medici, and partly erected by Philibert De Lorme and Jean Bullant. Such was the state of these two palaces, when Henry IV. mounted the throne; and as soon as he was at leisure, he determined energetically to embellish that Paris, which he had purchased at the sacrifice of his religion. He carried out the works, that united the two palaces by continuing the gallery along the bank of the Seine, and prolonging that end of the Tuileries. He added an upper story to the projecting wing of the Louvre, at the S. W. corner, upon which works Du Cerceau was first employed, until he left France in 1598. Du Cerceau was succeeded by Du Perac, and after him in 1602 Métézeau took part in these operations. Henry IV. also completed the Pont Neuf and the Hotel de Ville. It is also worthy of incidental notice, that Cosmo II, Grand Duke of Tuscany, from the affection he bore to Henry IV, who had married Marie de Medicis, after his death sent an equestrian statue to Paris, when Louis XIII. ascended the throne, and this was the first monument of the sort put up at Paris in memory of the French monarchs.

It was under the son of Henri IV. that the Louvre first commenced its development upon its present large scale. During the able ministry of Richelieu its present extent was contemplated, which rendered its court four times the size of its original dimension. Le Mercier was employed as the architect, and he extended the two sides already altered and faced by Pierre Lescot, and completed the square by adding the two other long sides; the principal entrance was under the Central Pavilion, next the Tuileries. This however he rendered overpoweringly lofty by adding an attic with colossal caryatides, which crush by their gigantic proportions the details of the lower stories. Le Mercier only executed the entrance story of these new parts, and pulled down the Northern and Eastern sides of the old chateau. The grand entrance in the centre of the North side is enriched with coupled Ionic columns, the idea of the whole arrangement being supposed by Argenville to have been inspired by the entrance vestibule of the Farnese Palace, at Rome, and somewhat similar to the more recent noble entrance vestibule of our Somerset House, by Sir W. Chambers, which it might perhaps have suggested.

In 1660, that is after thirty-six years' service in works of the highest order, carried out with the greatest talent, Le Mercier died wretchedly poor like his predecessor Serlio. At this time Louis XIV. reigned, and Le Vau was directed to continue the works at the Louvre, and he carried them on with an activity which was peculiarly his characteristic. He also extended Northwards the Palace of the Tuileries, so as to correspond with and equal in length the South end, already erected by Henri IV. But in 1664, the great Colbert being minister, a man of enlarged ideas and noble conceptions, found

that the style of Le Vau was not sufficiently dignified, and did not correspond with the magnificence, which should distinguish a royal palace. Although immense sums had been expended by Le Vau, he determined at once to stop the works and reconsider the design, which had been too hastily adopted, convinced that posterity did not at all consider the cost of a building, if its beauty answered expectation, whereas no consideration of economy ever reconciles after ages to an unsightly inappropriate edifice.

THIRD EPOCH, OR THE EXTENSION.

Colbert consequently determined to throw open the whole matter to public competition, and the architects of Paris were invited to send in designs. It appeared, however, that although the professional brethren of Le Vau had been willing and ready to prove, by very sound arguments and criticisms, the defects of Le Vau's design, they were incompetent to conceive others of superior merit, and they were rejected. But there was an eminent physician, a mere amateur of art, who submitted a project, which, novel in idea, bold in conception and dignified in character, seemed to equal the expectations of the magnificent Louis XIV. and his minister. Claude Perrault, supported by the personal influence of his brother Charles, who was Secretary to Colbert, was fortunate enough to have his plan regarded with great favour, particularly as Le Vau's, which had been sent to Rome to Nicolas Poussin to submit to the judgment of the architects there, had been generally condemned. Then the artists of Italy were invited to submit designs for the completion of the Louvre; and although numerous projects were sent in, still it appeared that the Italian artists, yielding to too lively and irregular a fancy, did not limit themselves to practical ideas, but gave themselves up to fantastic notions, which did not fulfil any of the conditions and restrictions required by the actual state of the building.

Louis XIV. and his advisers, disappointed at this result, and distrusting their own judgment as to the design of their own countryman Perrault, a physician, and not an architect by profession, were anxious to try whether the palace of the capital of France might not find its architect, worthy of its high importance, in the illustrious genius of Rome, who had added so much magnificence to S. Peter's by the enchanting porticoes of its fore-court, and had embellished Rome and other parts of Italy by conceptions of the highest class. Rome was essentially the republic of the fine arts in all periods. Sculptor, decorator, painter, or what not, every one conceived himself capable of being an architect; and Rome owes some of its most remarkable, though, perhaps, not its most beautiful monuments, to men who, without going through the preparatory ordeal of professional study and apprenticeship, had the courage—perhaps I should say temerity—to think themselves competent, prepared designs, and, by favour, were appointed to execute them.

Bernini, then in the ascendant, had certainly, by his colonade of St. Peter's, the Baldachino, and staircase of the Vatican, and the Church of l'Arrecia, proved that he combined fancy with judgment, skill, and taste, to a very eminent degree. His reputation dazzled the French King; and Bernini was invited to come to Paris to see the Louvre, and prepare a design. The cavaliere anticipated a Cæsar's victory, and the "veni, vidi, vici," result of the Great Roman. His journey to Paris was a triumphal progress. Deputations went out to meet him with speeches and memorials, as he approached the principal cities of Italy and France. When he neared Paris, an officer of the Court offered him the greetings of the "Grand Monarque," and a royal equipage and princely retinue conducted the no less illustrious artist to the anticipated scene of his future triumphal glory, where a noble mansion and munificent allowances awaited him and his assistants. But although caressed by the king and Colbert and the courtiers around the royal presence, the noble minded Bernini found that there were attacks

which genius, generosity, and frankness could not resist. The men he was brought to supplant called in question his talent, caricatured and maligned his intentions, defamed his works; a tide of defamation set in upon him. Under such unexpected malignant persecution, his imagination left him; he made a design, given in Durand's *Parallèle*, which too much ignored all that had been done before. Although remarkable for simplicity, and nobleness of plan, and breadth of effect in the elevations, it certainly did not answer the expectation formed, and he soon left Paris disappointed, yet not without munificent tokens of the regard and esteem of Louis XIV. and his courtiers, who admired his brilliant talents, and respected his fine personal character.

Perrault then resumed the place, which his previous success had gained him. His plans were adopted, and on the 17th October, 1665, Louis XIV. laid the first stone with great ceremony; and so great had become the impatience to which all the above-mentioned obstacles had given rise, that the works were commenced, and carried on with such order, that the new façade with the colonnade was completed in five years. It would seem that Perrault had adhered to the plan originally laid out by Le Mesurier and carried on by Le Vau, and had merely increased the depth of the mass of buildings on the south and east sides of the Court. I shall not stop to describe the features of Perrault's design, so well known to those, who have visited Paris and admired the noble colonnade of the Louvre. I shall only allude to one remarkable evidence of the character of the execution. The two inclined cornices of the central pediment consists each of a single block of stone, 54 French ft. long, 8 ft. broad, and 18 in. deep. Practical men will understand the difficulty of raising such colossal masses 100 ft. high and setting them in their place; and it is but just to bear this testimony to the architects of this period, that the constructions executed for Louis XIV., though carried on with extreme haste, are of the most solid, durable, and substantial nature: they were composed of the best materials, set out with all the most intricate skill of their celebrated science of the "*coupe des Pierres*." I inspected a portion of the grand flight of steps of the terraces of Versailles with my friend Mons. Nepveu, under whose direction that palace, during the reign of Louis Philippe, underwent considerable alterations and received extensive additions. That gentleman pointed out to me the extreme care, regardless of expense, with which the constructions generally of Louis XIV. were executed, and he assured me that the whole palace was carried out with the like scientific skill and attention.

The Louvre, by 1671, received its external coating of the colonnade, and had had £380,000 expended upon this new part, without receiving any of the internal fittings; in fact, we may consider that Perrault had laid out an amount equal to £800,000 of our time, on the mere carcase, as it were, of his operations during these eight years. But a new fancy, and that one no trifling project, had been begun about the same time as the Louvre—I mean the new Palace of Versailles, where Louis XIV. wished to create a new city and palace for the residence of himself and courtiers, in the midst of a sandy barren desert. In twenty-seven years Versailles absorbed £3,246,000. money of that period, which we may consider equal to seven millions of the present time. About £900,000 of our money were expended in the year 1686 alone. This new project cast into the shade the old Louvre of his ancestors, and as the purse, even of Louis XIV., could not bear the continued drain of two such palaces, the Louvre was left unfinished as it was, little more than a bare carcase.

This state of neglect continued for 70 or 80 years, until the middle of the last century, when the Louvre, instead of being a complete palace, with its internal fittings duly in order and a degree of arrangement prevailing, was but a mass of incoherent divisions, appropriated to various incongruous uses; devoid of the finishings usual even in ordinary dwellings, many of the windows unglazed, nay, unsashed; in parts without roof; portions occupied as warehouses and stables, or used for ateliers by

painters, sculptors, modellers, and various trades, and even for baser purposes. In some parts on the north side private dwellings were attached to the very walls. Monsieur de Marigny, superintendent of the royal buildings, remedied many of the gross abuses to which the Louvre had been subjected. Mons. Gabriel, the most celebrated architect of that period, and who erected the elegant "garde meuble" in the "Place de la Concorde," was charged with the completion of the façades and other works, which he carried on with great zeal and taste; and after his death Soufflot continued the operation. But the usual fate of this unfortunate palace never abandoned it; and after a few years the energy of reparation and completion relaxed, and this noble building, which, during the 120 years of the joint reigns of Louis XIV. and XV., had been begun, left off, and resumed, abandoned again and again, was still, when Louis XVI. mounted the throne, an incomplete palace, and almost as uninhabitable as when M. de Marigny commenced the Herculean task of cleaning out the Augean stable. The sad misfortunes of Louis XVI. and the horrors of the French Revolution supervened, put a stop to all public works, whether useful or ornamental, and matters resumed their usual state of chaotic disorder, leaving the occupation of its corridors, halls, and chambers to the chance of the most violent, daring, and ungovernable "sans culotte," who claimed a portion for his right, as a citizen privilege of "first come first served." It was as a town taken by storm.

FOURTH EPOCH, OR THE IMPERIAL.

At length Napoleon Bonaparte was declared Emperor in 1804, the star of the conqueror revived the past glories of the Tuileries and the Louvre, and a new era opened upon these palaces. The most valued spoils of his Italian victories consisted in the treasures of art, which he directed to be transported to Paris; but where were they to be placed? The vast scale of accommodation, which the Louvre offered, proved to be peculiarly adapted for the purpose, and M. Raimond, architect, was directed to prepare the halls and chambers to receive the new acquisitions—a vast and difficult operation, which he carried on with much ability and rapidity until his death in 1805. He was succeeded by Messrs. Percier and Fontaine, who had to reconcile the various incoherent parts, which existed in the elevations of the different sides of the court—to add in one part and to suppress in another; and they, with consummate skill, at length completed the court in about 24 years time, giving it that harmonious ensemble, which it at present offers, and which seems to be the result,—not of several ages each with its peculiar style,—not of numerous architects with different views and various tastes—but almost as though it were of one period and of one master mind. Thus the completion of the Louvre, both with regard to its structure and decoration, was accomplished within the first thirty years of the present century. It is not my intention to enter upon a critical review of the discrepancies of style, arrangement, or taste in the various parts of the Louvre. It appears rather a matter of congratulation than of criticism, when we consider that, amidst all the fatalities of its career, it should have escaped a total shipwreck; and that the noble mindedness of great men of state, and the exquisite skill of her architects, and their respect for the labours of their predecessors, should, under such obstacles, at length have preserved and handed down to us a monument of the very highest class of art. The Louvre forms a precious historical page in the annals of architecture, tracing with little interruption the various modifications of taste during three centuries. The exterior façades and the internal elevations are in themselves harmonious, though discordant from each other, and yet not offering so strong a contrast as to shock one's prepossessions; and, in fact, they nowhere evince deficiency of study, nor an absence of the very highest qualities of artistic merit, whether in the conception or execution.

FIFTH EPOCH, OR THE COMPLETION.

We will now turn to contemplate the great architectural fact of the present day, the completion of the Louvre and Tuileries, by their combination in every part, so as to form a congruous whole. Perrault had originally designed a project for this purpose, but here the deficiency of his ability as an architect made itself apparent. If executed, the addition would have thrown into the shade the Tuileries and the Louvre. He encumbered the intermediate space with 20 courts or vacant "places," square, oblong, octagonal, round, and elliptic; he surrounded them with edifices of all sizes, and of as varied forms. He lost all the breadth, of which the area admitted, and destroyed the dignity of ample space. The able Desgodetz vindicated his profession, towards the end of the 17th century, by a more noble arrangement, simple, and well understood; and, by a judicious disposition of certain masses of buildings, he masqued the differences of levels and lines, which existed between the two palaces.

The Emperor Napoleon entertained the idea of uniting the two palaces, but the practicability seemed beyond realization; for there existed an entire quarter of the town between the two, consisting of churches, palaces, streets, public institutions, and private houses, the mere purchase of which, and compensation for the trades and privileges of the inhabitants, seemed likely to absorb a considerable portion of a whole year's income of the Empire. However, numerous projects had been prepared from 1800 to 1812, and the illustrations before you present about 20 designs, from the hands of some of the most distinguished architects of the day. That of Messrs. Percier and Fontaine was approved by the government, and in consequence the north side of the Carrousel was, in 1811, begun to be enclosed for the length of about 700 ft., by a building corresponding with the Gallery of H  nri IV. on the south side. The Triumphal Arch of the Carrousel from their design had already been erected. The first stone was laid in 1806, and the cost, which amounted to £40,000, was paid by funds derived from the conquest of Holland. Thus did the conquered provinces of France provide the means for the memorials of their own subjugation.

It is obvious, from an inspection of the plans, that one great difficulty, in the geometrical disposition for the union of the two palaces, consisted in the want of verticalism and parallelism between the block of the Louvre, the long wing that united the palaces, and the extended front of the Tuileries. To reconcile these differences and produce symmetry of effect was the great stumbling-block of all parties, who, forgetting how ill able the eye is to detect slight differences in execution, and small divergencies of parallelism in distant masses of building, sought to reconcile these incongruities by intermediate masses, and expedients of circular ends to the court, or by subdivision and diminution of the "Place du Carrousel," sacrificing the noble character produced by vast space, and limiting the "*Colpo d'Occhio*." It was apparent, also, to some, that the Tuileries was deficient in domestic offices, residences for the household officers and persons attached to the Court, and particularly in residential accommodation for the immediate family of the Sovereign, the grand suites of saloons and apartments for Court ceremonials absorbing almost entirely the rooms required for domestic comfort. Some of the projects provided new wings, and "corps de batimens" attached to the Tuileries, next the garden; others on the other side of that palace, next the Carrousel. It had been, ever since 1805, a favourite project to transfer the great national library of the Rue Richelieu to the new constructions; and, throughout, one of the absolute conditions was to maintain the two main thoroughfares for even public vehicles, which have existed ever since the time of Louis XV.

Louis XVIII. continued, in 1820, the wing constructed by Napoleon, for an extent of some 70 or 80 feet. He died in 1823, and the brief reign of Charles X. succeeded, but no further addition was made. Louis Philippe, although promoting architectural works in Paris, thought it wiser to complete

the other public edifices, which he found in progress when he mounted the throne, rather than to begin a new project of such enormous cost. These were numerous and expensive operations, and certainly Paris, at his expulsion, had assumed a more complete aspect than it had ever hitherto done. After the Revolution of February, when the Republic was proclaimed, the project of the junction of the palaces was revived, as a judicious mode of tranquillizing the turbulent disposition of the working classes, apt to create "*emeutes*" when not employed.

In 1835, Mons. Brunet Debaines, now of Havre, and our Honorary and Corresponding Member, prepared a very fine and comprehensive plan for the additional family and household accommodation in connection with the Tuileries, and for the allocation of the National Library, galleries for the exhibition of works of industry, and also for the opera house and chateau d'eau in the Place du Palais Royal. He forms a central square in the Carrousel, 900 ft. wide by 750 ft. long: at each corner of the present Carrousel, next the Tuileries and next the Louvre, he forms masses of buildings with a central court, projecting about 200 ft. into the court from the long sides, north and south, extending 400 ft. from the Tuileries and the Louvre respectively: thus resolving the great court into a species of Greek cross. In each of the masses of buildings next the Tuileries he forms two courts for stables and coach-houses, domestic offices, accommodation for the persons attached to the Court, and family conveniences for the Royal Family, compactly disposed. The courts next the Louvre are respectively appropriated to buildings for the library, and to an extension of the picture galleries.

My friend Mons. Dusillion exhibited a design in 1849, the leading features of which are similar to Mons. Visconti's. He continues the wing begun by Napoleon up to the place opened in front of the Palais Royal; here the line of frontage then breaks back about 25 ft., and its direction is changed so as to be at right angles to the place and to the axis of his new building. By another slight break just beyond the place it forms another recess, and is continued until it comes in a line with the wing of the Louvre built by Percier and Fontaine, where it turns round to meet the Carrousel. At the distance from the Tuileries of about two-thirds the length of the court, Mons. Dusillion throws a building quite across on the line of the axis of the Place du Palais Royal, with two projecting wings producing a noble inner court next the Louvre, 500 ft. wide by 400 ft. deep, called that of the Bibliotheque Nationale, and smaller courts, 100 ft. wide, are enclosed within the "*corps de batimens.*" His conception is simple and dignified. He preserves the axial *allinements*, and still a noble extent for the Carrousel of 1050 ft. $\times$ 900 ft. Faithful to one idea, Mons. Dusillion devotes the whole of his new building to the reception of the vast collection of books, medals, and other objects of the great National Library, by a very imposing and convenient distribution of halls, staircases, and galleries; and their junction with the Louvre is direct and easy. Any addition to the domestic accommodation of the palace of the Tuileries forms no part of this design.

THE DESIGN OF MONSIEUR VISCONTI.

To comprehend properly this project, we must understand the programme traced by the hand of his Sovereign, and which it had to satisfy; the idea of transferring the National Library to this site was abandoned. The Emperor Louis Napoleon wished, that accommodation should be provided for the residence and administration of his two Ministers, to whom was confided the execution of all public affairs. His Majesty also desired that provision should be made for the periodical exhibition of the works of modern artists, so as to relieve the pictures of the old masters in the Louvre from being covered up, and those galleries from being appropriated for that purpose, as had hitherto been necessarily the case. There was to be stabling for 140 horses, and coach-houses for 50 carriages for the use of the Emperor and public purposes.

Let us now see how this has been accomplished. Mons. Visconti has continued the line of front next the Rue de Rivoli in one continuous direction, and without any other break than slight projections here and there to relieve the monotony of an uninterrupted façade. On the axis of the Place du Palais Royal he introduces a central entrance to the ministries, and carries out into the Carrousel a block of building 700 ft. long $\times$ 290 ft. deep, projecting into the grande place 230 ft., and containing two large courts averaging 200 ft. $\times$ 140, and one less court 140 ft. $\times$ 80. This block he appropriates to the two Ministries of State and their dependencies. From the long gallery next the Seine he throws out a like block into the Carrousel, 600 ft. long $\times$ 230 ft. deep, with two courts larger than those previously described, and a similar smaller court. A very grand staircase will lead to the first floor, which, as well as the entrance floor, is to be appropriated to the annual exhibition of modern works of art; they will also connect with the galleries of the Louvre containing the old masters. In the centre will be a most splendid hall, two stories high, richly decorated, 67 ft. wide, 200 ft. long; this will be used for the meeting of the "Corps d'Etat" when the Emperor wishes to convoke them. There will be a riding-house of like size beneath in one clear span, and in the basement story the stabling for 140 horses, and under the old gallery next the Seine the coach-houses for the 50 carriages.

The central block in the right wing facing the Palais Royal, and on the same axis as it, will form a noble entrance hall, vestibule, and thoroughfare for foot-passengers and private carriages going from the Place du Palais Royal to the Place Louis Napoleon, as the space between the two wings is to be called, the centre being occupied by ornamental gardens, like the square gardens in London, with fountains and statues of Louis XIV. and Napoleon I. In the centre, porticoes will face the Place Louis Napoleon, decorated with marble statues of the great men of France, and the whole architecture will correspond in style with that of the Louvre, with a more discriminate use of decoration and a greater relief by contrast. The present plain front of the Louvre facing the Tuileries will be made to correspond with the new building by a little more ornamentation than it at present possesses, for when originally designed by Pierre Lescot, it only faced inferior streets and dwellings, and was therefore executed with great simplicity and absence of decoration. To those so well competent to judge of the ability and reasonableness of this disposition of plan it is needless for me to offer any comment upon the skill and taste which have conceived it. But I cannot forbear to observe that it harmonizes and blends together the two incongruous and apparently incompatible masses of the old palaces—it reconciles the obliquity of the wings—it preserves the vista from the façade of the Tuileries up to the Louvre—by the judicious contraction of the Place Louis Napoleon it renders appreciable the vastness of the Carrousel,* still of gigantic extent, about 900 ft. square, sufficient to manœuvre squadrons of cavalry, and encamp (in case of need) its thousands of troops. There still, however, remains to be provided domestic, family, and household accommodation for the comfort of the Royal inhabitants, and hereafter will have to be added in contiguity to the Tuileries, and, either in the Carrousel or on the garden side, masses of building, to render this a comfortably habitable, as well as the most vast and sumptuous palatial residence in the world.

These colossal operations of the Louvre are but part of a vast series of improvements now carrying out, as you are aware, in Paris. The present Emperor, with his usual penetration, feels the full importance of giving employment to the industrial classes, of encouraging the fine arts, as among the finest illustrations of his reign, and contributing to the refinement of the people and the improvement of manufacturing productions. He equally appreciates all the influences upon the

* Size of Lincoln's Inn Square, 845 ft. $\times$ 625. Size of Russell Square, 700 ft. square.

health of the metropolis, and the advantages to commerce derivable from clearing away the old closely confined quarters, and opening up new lines of thoroughfares. The works at the Louvre are a portion of this extensive scale of operations to be promptly and vigorously carried out. The decree for the works necessary for this object was dated the 12th March, 1852, and a sum of one million and twenty-seven thousand pounds to be expended in five years, judged requisite. The first stone was laid on the 25th July following, and at the end of the same year the north wing had been carried up 6½ ft. above the level of the Rue de Rivoli. During the last year the contracts were entered into for the masonry, carpentry, and iron work for nearly all the parts of the new buildings to the extent of £800,000. In March last year 1200 workmen were employed, increasing in numbers until November, when 3000 were on the works, and in December, 2000.

192,000 cube yards of earth have been removed; and there have been worked up—109,000 cubic yards of stone and concrete; 300,000 kilogramme of iron are already used.

In 1852 were expended	£47,800
„ 1853 „	227,040
Making together	274,840
Besides other outlays, amounting to	48,714
Already expended	£323,554

The premature death of our lamented friend Mons. Visconti, the highly gifted architect, in December last was a grievous loss; but so unremitting had been his attention, so ready his conception, that, when I visited Paris in October last, he showed me between 150 and 200 drawings of details, which he had prepared; and in which the particulars were so minutely specified, that the work, if carried out agreeably to them, will have that unity and grandeur of conception and refinement of taste in every part, that will stamp this as one of the greatest works of the age. The architect, with noble disinterestedness casting aside all personal considerations, has conformed to the style of the original type, and will leave it as an inspiration of the 16th century, matured by the experience, refinement, and masculine good sense of the 19th.

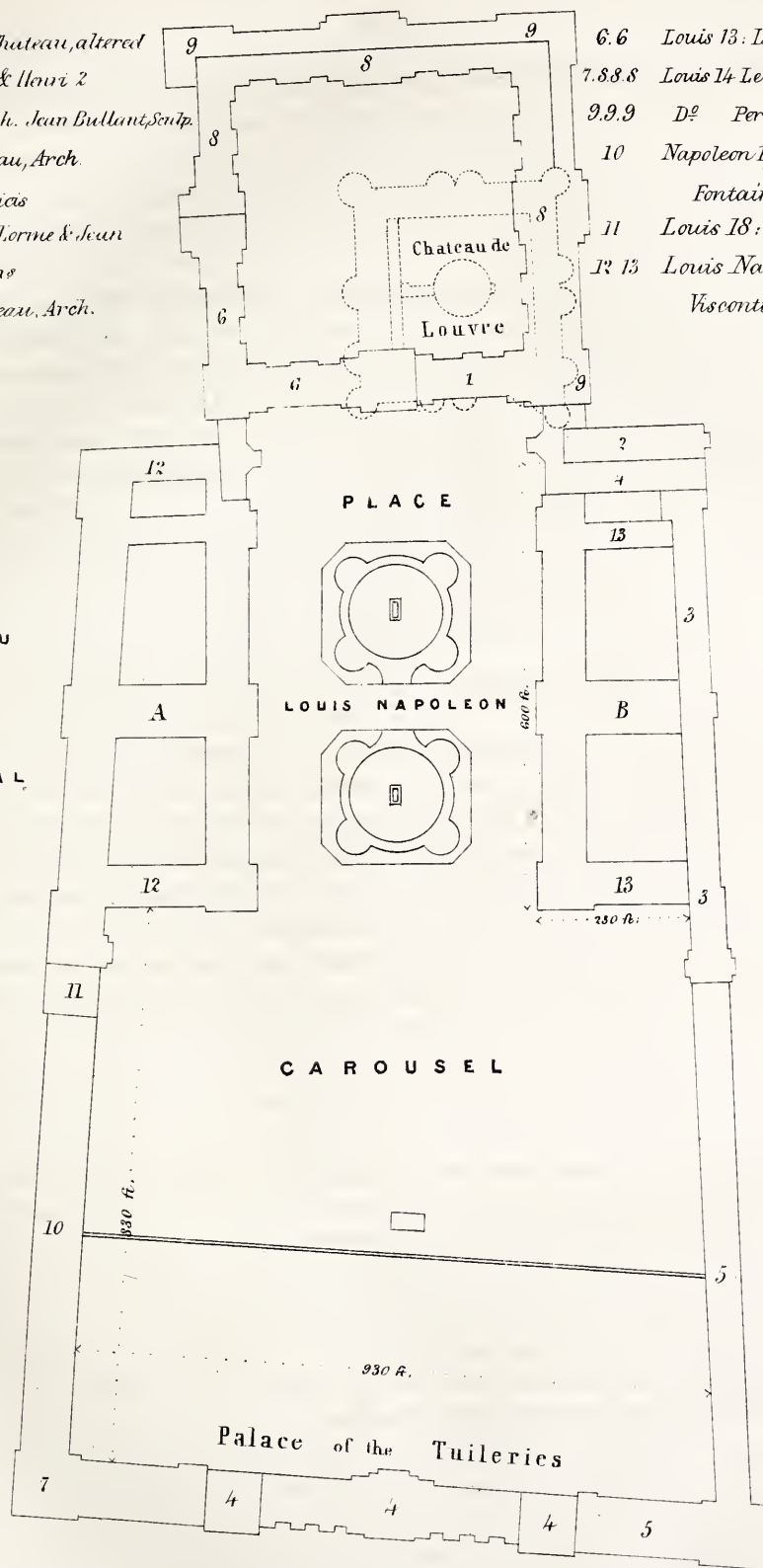
NOTE.—The preceding historical details are founded upon the information contained in the following Works, in addition to the writer's personal knowledge of the buildings in question:—*Des plus excellents Bastiments de France*; par Jacques Androuet Du Cerceau, 2 vols. folio, Paris, 1576-1607. *Mémoires sur la Réunion du Palais Imperial des Tuileries et du Louvre, et Plans de diverses dispositions pour l'achèvement de la Place du Carrousel*; par Baltard, Architecte, folio, Paris, 1811. *Arc de Triomphe des Tuileries, érigé en 1806, d'après les dessins et sous la direction de MM. C. Percier et P. F. L. Fontaine*, oblong folio, Paris, no date: (containing numerous projects by various authors for the union of the Louvre and Tuileries.) *Projet de Restauration et de Réunion des Tuileries au Louvre*; par L. Fortuné Brunet-Debaines, Architecte, small folio, 1835. *Description Historique et Graphique du Louvre et des Tuileries*; par M. le Comte De Clarac, Conservateur des Antiques du Louvre, 8vo. Paris, 1853.

- 1 Side of the Old Chateau, altered
by Francis I.^e & Henri 2.
Pierre Lescot, Arch. Jean Bullant, Sculp.
- 2 Henri 2. Ducerceau, Arch.
- 3.3 Catherine de Medici
- 4 D^e Philibert de l'Orme & Jean
Bullant, Arch.
- 5.5 Henri 4. Ducerceau, Arch.

- 6.6 Louis 13. Lemercier, Arch.
- 7.8.8 Louis 14 Le Vau, Arch.
- 9.9.9 D^e Perrault, Arch.
- 10 Napoleon 1. Percier &
Fontaine, Arch.
- 11 Louis 18. D^e
- 12.13 Louis Napoleon.
Visconti, Arch.

PLACE DU
PALAIS ROYAL

RUE DE RIVOLI



100 0 100 200 300 Feet

Vincent Brooks Litho King St Covent Garden London

PLAN OF THE LOUVRE & TUILERIES, PARIS,
with the additions for the Completion & Union of these Palaces.



ON THE DRAINAGE OF BUILDINGS AND STREETS IN THE METROPOLIS.

By W. A. BOULNOIS, Associate.

Read at the Ordinary General Meeting of the Royal Institute of British Architects, March 20th, 1854.

IN venturing to offer a paper on this subject to the Institute I have not been influenced by a desire to communicate any special experience or information of my own, but simply by a wish to induce a discussion upon the controversy which, as we all know, has long existed, upon the methods and schemes of house drainage. The question lately received a great deal of attention at the Institution of Civil Engineers, and complaints have been loudly made by some of the disputants that their opinions did not receive sufficient notice in those digests or summaries of the proceedings in which the Institution is wont to condense the information derived from a debate. Here they will be able to express their opinions without reservation, none of our principal members being, as far as I am aware, pledged, as they contend the principal members of the other house were, to one side of the question; and they will be reported precisely in proportion to the clearness and accuracy of their remarks.

Every member of this Institute is, I am sure, anxious that the subject of drains should be well ventilated, however doubtful he may be as to the manner in which the drains themselves can best be so.

It would really appear strange to any man unacquainted with the deep-rooted prejudices, and the hot-headed partisanship of Englishmen, that a matter involving their most important interest, their health, their money and their pride, should not ere this have been fixed upon such principles, that though there might remain a disappointed opposing few, the vast majority would have been entirely of one mind. When we consider the composition and character of the respective Boards of Metropolitan Commissioners of Sewers, since the public has been roused to the need of efficient servants in that capacity, the talent and ability of almost all their officers, we are fairly surprised that a controversy should be still raging as well on the things to be done as the manner of doing them. It is not too much to say that the ablest men of the kingdom have occupied themselves generally with the sewer question. It has been the disagreement of professional men upon details, which has alone prevented their labour from bearing fruit. And now that we are nearer to a settlement of the question, we find that the finances necessary to carry out the measure, have not been considered or provided for, as it was not worth while to prepare the way for expenditure, whilst the manner in which the money should be spent was undetermined. Surely it should be the earnest wish of all right-minded men, without prejudice against new-fangled notions, as they are termed, on the one hand, or an absurd retention of theories unsupported by practice on the other, to arrive at such a conclusion on this subject as shall obviate the evils complained of. This is not to be done by avoiding controversy within such walls as these or in papers and pamphlets, in which facts and opinions can be stated and refuted, but by abstaining from abuse of all parts of a given system of drainage, because one's own nostrum is not in it; by abstaining from false and overstrained statements of wasteful expenditure as it is termed, because our own nostrum is not experimented upon; and especially from a system of hand grenade penny-a-line warfare, which has been the destruction of all the respect usually felt by the public for bodies of scientific men who are desirous to serve it with honour.

It is a custom with architects now, I think, much more honoured in the observance than in the breach, to begin all descriptions of practice with a reference to the ancient methods. I cannot do the justice to this part of the subject which it deserves, and which many here present could, but in con-

firmation of what was said the other night as to the antiquity of the claims which most modern inventors set up, I may refer to some portions of tubular drains brought from Ephesus and Miletus by my friend Mr. Falkener, which are now on the table. I learn from him that there is ocular demonstration of the use of similar drains at Pompeii; in one case the hollow in which the pan was bedded in the wall clearly indicates its shape; it was on the first floor, and from the curious arrangement of the syphons, which are described as existing in the ornamental arches of the City, we may fairly conclude that the Pompeians had WATER closets. As the drains were laid under the ornamental pavements through the principal portions of the house, and centred in the impluvium passing away in one channel through the prothyrum or passage, we may conclude that probably, from a greater fall, better workmanship, and the constant running of water which took place from the fountain in each house, they did not require to be so frequently laid open as ours do. No excavations have been made which shew the size of the sewers in the streets at Pompeii, and it is greatly to be wished that some one competent would investigate this subject—permission would readily be granted for the purpose by the authorities at Naples to any one so well recommended, as an advocate of the pipe system would now probably be, by the Secretary of State for the Home Department.

At Pompeii there are indications that the same construction of the street water-courses under the pavement or trottoir, which exists now in the Corso, at Rome, was practised.

I have endeavoured to explain this by the drawing on the wall: the water-course is entirely under the pavement, which is of travertine, hollowed to form a series of long arches over it. There are some advantages connected with this method which might warrant its adoption in our streets; a much greater fall could be given to the water-course so as to obviate those elongated puddles, which after heavy rains are not uncommon near the gulley heads in our streets: the kirbs would not be so much worn as they are at present from the custom of using them as trams by weighty carts, and the horses would be relieved from the strains—necessary to remove heavily laden vehicles from them. I have been informed that this is the most fruitful cause of jibbing in horses, and that in some parts of London it is a serious injury to the omnibus proprietors.

The pipe drainage advocates having antiquity on their side as regards house drains, it is satisfactory, on the score of an even debate, to find for the large sewer advocates, the CLOACA MAXIMA at Rome. We are, however, indebted for more than would first appear of our present system to the Romans. Our system of sewers originated in the covering in of open water courses, and at the Fleet-ditch and the Wallbrook sewers, old Roman brickwork is intermingled with modern work, or was until quite recently. The present adaptation of the sewers has been the growth of a long and very costly rule of thumb system. All the men who have since Wren's time been consulted about sewers, and they are not few, were probably unable to apply, even if they were acquainted with, the principles of hydrodynamics. They were employed on piecemeal improvements, and it is fortunate for us that the earliest of them did their work so well as to set tolerable examples before the ignorant parish authorities and inefficient surveyors, who, until comparatively modern times, have managed the drainage of London. It is a subject of great congratulation, as it seems to me, that of the 1,000 miles of sewers constructed under the Commissioners, and the 50 miles of City sewers, there should be such a large proportion which is useful, when we consider its progressive development, the divided interests which have worked it out, and the uncertain and hap-hazard way in which the extensions to this great town have been made. It is quite certain, moreover, that we have derived all our present knowledge of the subject from the imperfections of the previous works, so that we have in that way largely benefited by the mistakes of our forefathers.

The division of the subject of the removal of refuse from the buildings and streets of the metropolis, which is most simple, and admits of the readiest discussion, is into DRAINAGE, SEWERAGE, and OUTFALL. DRAINAGE has to be considered under the head of *subsoil drainage*, *surface drainage*, and *house drainage*. The necessity of subsoil drainage in a locality entirely sublain by an impermeable stratum, such as the London clay, needs no argument; and though it has been, and is ignored by many Sanitary Reformers, it is in fact almost as important as the house drainage. Damp soils and damp basements to houses are as constant and as deadly destroyers of human life as all the foul emanations of undrained refuse. The economy of effecting this subsoil drainage by the same sewer which is to convey the house drainage admits of no question, as it seems to me; and it is very efficiently provided for by the construction now adopted in the sewers of the Metropolitan Commission, which are built in cement to the height of the internal flow, and in mortar over this, which admits of the percolation of the water in the soil above and around them. The City has long been pre-eminent in respect of its subsoil drainage over almost all towns in the world.

One of the places most insisted upon as an experimental proof of the efficacy of the pipe drainage is Tottenham. Now there is a portion of Tottenham, lately called Marsh Lane, but now Northumberland Park, where the system of the Board of Health has been most efficiently carried out by Mr. Pilbrow; the houses are well drained, but the subsoil drainage not being provided for, the basements after heavy rains stand in water: the year before last the water rose in the basements of some, which I had occasion to visit, 18 inches, and had so saturated the walls as to injure them permanently. Had the drainage been according to the system of the Metropolitan Commissioners of Sewers, this most serious evil would have been avoided, and the house drainage equally good. I am aware that a sufficient fall could only have been obtained at a great distance, and that the present system is the only one the place could yet pay for; but it affords a strong proof of the great gain which, when there is opportunity, arises from the combining the subsoil and house drainage.

The surface drainage, by which is meant the removal of the rain water, is that branch of the subject which opens up the question of small or large sewers. The rain-water which falls on a given area, would seem to be specially intended for the cleansing of the refuse which may be on the surface, and very good reasons should be given why this is objectionable as applied through the sewers before we depart from so natural and obvious a use of them. The chief reason given by those who seek to separate surface and house drainage is an economical one, the cost of the sewers they say may be reduced to such an extent that you can have two systems, one for house and the other for surface drains, at a less expenditure than you can construct your sewer large enough for both. Now granting for the moment that the systems of small sewers will do for *house drainage*, as perhaps it will in some special and favourable cases, it is unquestionable that sewers large enough for the passage of a man to clean them would be required for the rain water or surface drainage in this metropolis, the detritus from Macadamized roads forms a concrete much more difficult to remove than all obstructions in sullage, and no gulleys (of which one of the best forms as found in the experience of the Metropolitan Commissioners is exhibited on the wall,) are able to prevent this deposit from accumulating in our sewers.

We in this Metropolis, with our levels, if we desire to be able to cross our streets without boats, and occupy the basements of our houses for more than two hundred and fifty out of the three hundred and sixty-five days in the year, must have sewers for the rain water, not of the theoretical size requisite to carry off a given rainfall, but of size sufficient to admit of these sewers being approached for cleaning.

The economical reasoning therefore fails.

The theory so carefully elaborated in some of the treatises on drainage, of forming surface drains

literally at the surface, and only covered by the requisite thickness of stone or other material to protect them from the carriage traffic, and admit of their being easily cleansed of the road-dirt, forgets that the front areas and rear portions of London houses, the gardens, and the basement areas are usually 12 or 14 feet below the street level, and totally neglects them.

Having then the necessity for large sewers for the *surface drainage*, and of deep sewers for the *subsoil drainage*, we are next to inquire into their applicability to *house drainage*, or the substitution of other methods. Great improvements have within the last half century taken place in the *house drainage* of the Metropolis, independent of the question of the size of the drains. Cesspools are, I believe, no longer contended for. Water-closets are considered essentials by a class of people, whose fathers would have as soon expected to ride in their own coaches as use them; and that periodical and dreadful infliction upon Mr. Paterfamilias of "something wrong with the drains" is within the houses at any rate, less frequent than formerly. This last effect is doubtless attributable to the general use of the tubular pottery drain, not that all the improvements have been made with it, but because the builders and bricklayers who would not use it, were compelled in support of their prejudice in favour of the old barrel drain, and for the honour of the cause, to build their brick drains somewhat more smoothly than they had been in the habit of doing. The main cause of improvement, however, is the information which was given to practical men by scientific men upon the necessity of an uniform inclination in place of the flat incline and sudden fall near the sewer, which was commonly adopted in house drains, and the knowledge which has reached even housemaids and footmen, that a good scour of water through the drains is better obtained by a plug under the lifted water-closet handle during the coming in of the water supply than by the old and time honoured expedient of pouring pailful by pailful down the grating in the back area.

Greatly indebted we are to the sanitary reformers on this subject, and we may offer ourselves the same congratulations upon their experience as we do on the practices of our fathers; we know now what to avoid. Their two inch pipes from sinks, three inch house drains, and four inch combined drains, are now as much things of the past amongst practical men as a cess-pool under the centre of the front kitchens; four inch pipes from sinks, and six inch from water-closets, are the smallest which practice has warranted us in adopting. Theory proves, and proves satisfactorily that a three inch pipe with the inclination ordinarily obtainable in London, would be enough to carry off the refuse from a first class house, but practice has discovered such frequent stoppages even of four inch pipes, that they are now scarcely ever used.

I could give the history of numerous and various individual failures which have arisen, but others will occur to all the members. We are sometimes told that these are *preventible stoppages*, and that the small drain gives increased cleansing power to the water in the contents, and is so much better as to warrant the adoption of the means to prevent the insertion of improper substances at greater cost than we are now accustomed to do: in other words, that the trap should be improved and altered. How often would even the three inch drain be quite full of water so as to push the substance in suspense before it? This great and inherent evil of *stoppages* is sometimes met by saying that you must teach the people not to put matters down the drain which will cause stoppage, and that a population must be thoroughly imbued with the belief that the omission and commission of sins against the drains will cause a recoil upon themselves in disease and death; but we must change the character of the human mind before this desirable period will arrive; do not men commit sins of omission and commission upon the ducts and sewers in their own bodies, knowing that they will recoil in the shape of disease and death?

The most fruitful causes of the failure of pipes have been the joints; butt joints are specially liable

to this observation : when laid in ground which is not very solid and consistent, the lengths are liable to shift and an irregularity causes a lodgement of a small portion of the matters floating down ; once begun, the evil speedily accumulates, the obstruction gathers from each passing substance which is not of sufficient tenacity to resist it, and eventually entirely chokes the pipe.

With reference to whole socket pipes, practical men are divided in their opinion as to whether they are best set in clay or cement ; for my own part I think it essential to pipe drainage that no extraneous matter should possibly get into the pipe from the outside, and I think they are best set in cement. All house drains are best waterproof, a stoppage may, if this is not the case, exist for a long time in a drain without detection, as the fluid sewage oozes through the joints and saturates the surrounding ground. In a gravelly or sandy soil this evil may have been proceeding for months without notice. Half socket pipes I think are the best, as they offer the opportunity of removal without breaking them upon the occurrence of stoppages, and it is more easy to determine when they are accurately laid, the upper semicircles of the two pipes abutting against one another affording a good test of this. The thicknesses of the pipes have, with very sound judgment, as it seems to me, been increased by the resolution of the Metropolitan Commissioners of Sewers ; they must now be $\frac{1}{2}$ in. for 4 in., $\frac{3}{4}$ for 6 in., 1 in. for 9 in., and $1\frac{1}{2}$ in. for 12 in. beyond this. The Commissioners do not permit pipe drains within their jurisdiction, as they have been found to break and cause great damage and expense.

The glazing of the tubes inside, though very desirable and of indirect utility in causing a better pipe to be burnt than would otherwise be, is not of any material assistance to the flow of the sewage matter through them. There forms in all sewers a sort of slime against the sides and bottom, which is after a very short period as efficacious in giving a smoothness of bore as the most expensive glaze would be. Too much attention cannot be paid to the bedding of the tubes at a true inclination, a very small error in the levels being of much more importance than in a large drain, where there is opportunity for adjustment of an even inclination in the current : it is obvious that 3 inches wrong with a 6 in. tube on a very flat incline, will be equivalent to the stopping up of half the tube.

With reference to the question of using *back combined drainage*, or a *separate drain* from each house to the sewer in the street, there are many considerations which are not usually taken into account by those who advocate the first of these systems. We have seen that street sewers are necessary on account of the necessity for *surface drains*, and that they must be so large for this special purpose as to admit of their being applied also to receive the *house drainage*, (I do not apprehend that the most earnest advocate of back drainage ever proposed that the surface drainage of the street should be at the rear of the houses). We have then to consider whether it is better that the block of houses should be drained at the rear in the back courts or gardens by a combined drain which is turned into this sewer at one point, or that each house in the block should have its separate opening into this sewer. I pass by the considerations of invasion of private property involved in the combined back system, and the more serious danger of intentional stoppage and cutting off the drains, of which perhaps nearly all of us here have seen instances, as they are by no means uncommon. I pass by the necessity which in almost all cases there would be, that the combined drainage of the whole block should flow under the end return house, and the much greater liability there would be that a stoppage should occur in the small drain, say of 12 in. diameter, than in the sewer in the front, and that all the inmates of houses in the block would be the sufferers for the neglect of one. I pass by these considerations, though they are enough to prevent the adoption of back drainage without strong local reasons in its favour, and I come to the main point at issue between the advocates of one system and the other, viz. the economy. Now, first we must have a drain from the front area in all streets, so that we have the length of the drain from the front area to the water-closets, and sink in the basements

and the back area, if there is one, to set against the length of the drain from the water-closet and sink to the back combined drain, and the frontage of this combined drain along the house. Almost invariably with modern houses in blocks, there are rear projections, which are quite as wide as the front area, generally they are wider, we have therefore to set the extra length of the pipe in the house, (on the supposition that the sink and water-closets are at the rear as they usually are) against the frontage, and we have in this to set 12 in. pipe frontage, and one 12 in. T piece, diminishing to 6 in. against a straight 6 in. pipe through the house. It is clear that in nineteen cases out of twenty, back combined drainage would be more expensive than separate front drainage, provided they were both equally well done. It suits well perhaps with the views of speculative builders in outlying parts of the town, where there are no basements to the houses, and surface drainage is not yet provided for; the parishes not having had the roads and pathways handed over to them; to obtain permission to insert all along the rear of their blocks before their garden, or back court fence walls are up, a cheap 15 in. drain instead of an efficient sewer in the street; but it is of immense importance that their views should not be complied with to the prejudice of the health of the inhabitants of their houses, and the property of the persons who purchase their interest in the houses when they have let them.

Were each man who builds in this country his own freeholder, there would be no question as to the combined back drainage, it would not be tolerated; and because we have a vicious system of leaseholds which enables such propositions to be entertained and to be hailed by some of the small builders, are we to be told that the Commissioners of Metropolitan Sewers, who have wisely permitted the system only under such local circumstances as make it obviously desirable, are neglecting the objects of their appointment and stifling the truth.

We now come to the second division of the subject—SEWERAGE, by which is meant the arterial drainage from the house drains to the out-fall.

We have arrived in considering subsoil and surface drainage at the fact, that a sewer larger than the theoretical size is necessary, and after making due allowance on that account, we can with tolerable accuracy determine what should be the sizes of the sewers. As they gradually approach their outfalls they receive increased amounts of drainage from the increased area they traverse; the average of the make of sewage over a given area of inhabited houses in London has been tolerably accurately obtained by experiment.

It is found that in six hours in each day, as much sewage comes down as during the remaining eighteen hours; the rainfall is taken by the engineers to the Metropolitan and City Commissioners at $2\frac{1}{2}$ in. over the entire area, after making proper deductions for the effect of evaporation and absorption in dry ground, and upon the formula of the square root of the hydraulic mean depth, multiplied by twice the fall in feet per mile, minus one-tenth for friction, equalling the velocity in feet per second, the capacity of the sewer can be calculated. It is a fact seldom admitted by pipe sewer advocates, but nevertheless true, that many of the old London sewers are too small, as well as many too large, upon this principle.

It is sometimes forgotten in the controversy on the part of the pipe advocates, that upon true hydraulic principles, the sizes of the sewers as calculated for their drainage capability only, soon reach such dimensions as that pipes are no longer available, even if they answered their ends. Besides, were they laid with reference only to the immediate requirement in places where they would be sufficiently large for it, they do not admit of extension to embrace the drainage of an increased number of houses, a point very necessary to be considered on all grounds.

Pipe sewerage may be said to have been well tried in the Metropolis, and to have failed. On the wall, are instances, by no means the worst of the condition of pipe sewers, as ascertained by Mr.

Bazalgette, the engineer to the Metropolitan Commissioners, by their order. Many of these it appears were habitually flushed, and the investigations were made by the officer to the Commission, solely with a view to ascertain the applicability of pipe sewers in the future operations of the Commission. The present shape adopted by the Commission, answers as far as its bottom goes all the ends of a circular sewer in diminished friction, and as the perimeter widens, it must, (by the well-known principle of hydraulics that the resistance of every particle of the fluid is in direct ratio to the perimeter of the section, and inversely, as the area of its section) give beyond the semicircle a greater velocity in feet per second.

The sewers now built under both Commissions, are constructed upon sound hydraulic principles, and we may hope that there is no waste of public money for want of an ample scientific knowledge, both of the requirements, and the best method of answering them.

There are details connected with the sewerage which it is worth while to allude to, as many differences of opinion exist upon them: the ventilation of the sewers is one of these: it is admitted on all hands, I believe, that till we have a perfect water supply, and our sewers are scoured as those of Paris now are, by strong streams of water, provision must be made for the occasional passage of labourers in them to cleanse them. And even when this much to-be-longed-for time arrives, entrance will be necessary for the repairs, which will be rendered more frequently requisite by the scouring. If the sewers are to have labourers in them they must be ventilated, and it is a question which is the best method of effecting this; many schemes have been proposed.

A direct air shaft leading to the centre of the street is adopted by the Metropolitan and City Commissioners, though, they admit, that it is open to great objection. A plan which has been used with success in many places, is to connect the rain water stack pipes with the sewer. Mr. Varley, the water colour painter, read a paper at this Institute, in 1846, descriptive of this method; his diagram is on the wall. Shafts and furnaces for draft have been proposed, but would entail enormous cost. It has been proposed to compel all persons having steam boilers for manufacturing purposes, as brewers, mechanical engineers, and the like, to admit the foul air from sewers to their chimney shafts, but it is doubtful whether this would answer. The chimney shafts would hardly always be in the highest levels and very long adits would have in most cases to be run to the nearest sewer. Dr. Buckland came down here one day to propose that the gas lamps, in certain requisite numbers, should be connected with the sewers by shafts, and that iron cylinders should convey the foul air outside the stalk of the lamp to the flame which would consume it, or destroy its noxious qualities.

Some have proposed, that every house to be built or re-built, should be compelled to have a flue in the party wall for the use of the Commissioners of Sewers, should they need it, to ventilate the sewer at that part; this does not seem an impracticable plan, and perhaps it will be considered in the New Building Act, which, we have been informed, is now in the hands of the Board of Health. At any rate, ventilation in the sewers must be provided.

Flushing, is a point to be noticed in the consideration of sewers. Great improvement has been made in this method of cleansing the sewers, and with a perfect water supply, there is no reason why it should not be extended to such a degree, as to almost entirely obviate other methods, except in flat situations, where raking will probably always be requisite.

A system of flushing has been proposed by Mr. Jennings, (whose clever contrivances in connection with drainage details, entitle him to the thanks of all architects and sanitary reformers, and some of whose inventions surround us), in which the accumulated refuse of each day is released at a given moment from a receptacle constructed under each house, any number, say 100, such receptacles being opened at once by the aid of wires and cranks, or electricity, it is supposed a rush would take place

down the sewers which would clear everything away with it. Another invention by Mr. Salter, to which my attention has been brought by Mr. Jennings, is the self-acting flushing gate, in which by an outflow pipe from the upper level, communicating with a tilted box on the lower level, or in the side entrance, the sewer itself, when full, forces up a catch lever and releases the gate. It is very ingenious, and is recommended from experience by the authorities at Leeds.

Time will not permit me to treat of the many other matters connected with the sewers, which will, I hope, come out in discussion, but we must pass to the *OUTFALL*, on which I can say but very little, except that having read digests of all the schemes submitted in competition to the Commissioners of Sewers, I do not believe there is one except that of Mr. McLean, for intercepting the higher levels, and taking the lower under the Thames at Vauxhall, which is practicable, without such an enormous outlay of money as to quite preclude it from consideration. The engineer who devoted so much time to the question, and whose health failed him in the attempt to conduct the multiplicity of detail connected with his office simultaneously with the designing of a great scheme, died before he could mature it, and it remained for Messrs. Bazalgette and Haywood to work out plans for the main drainage of the Metropolis. It may be shortly said of this scheme, that the new sewers proposed intercept the present at various levels, and form of themselves the sewers of the districts through which they pass. The schemes have met the approval of Sir William Cubitt and Mr. Robert Stephenson, both eminently practical men, and it is satisfactory to find that Lord Palmerston does not include them in his condemnation of the Metropolitan Commissioners' plans.

Were Lord Palmerston for one week at the Sewers' Office, or even had he to make application there so frequently as we all have, he would have long considered before he took such a violent course as to declare the whole of the proceedings of the Metropolitan Commissioners, since they had been in office, erroneous. Lord Palmerston would have known, that at any rate they had endeavoured to get at the truth; he would have known, that seeing the rock the two previous Commissions had split upon, viz., chimerical scheming in the one case, and a neglect of detail for a grand measure in the other, the Commissioners were now only anxious to do their work so that it should be lasting and beneficial. He would have known, that their officers were selected with the utmost care, and that no crotchets now took up the time of these officers; no endeavours to make out cases, which, if proved, could not be carried out without an entire remodelling of the whole Metropolis; no rival schemes within the very executive office of the Commission taking up the time which the public was paying for; and before he took a step likely always to deter sound men from engaging in the public service voluntarily, he would have waited till he was better informed than he could be by a letter containing heads of a controversy, most of which are long since settled in practical men's minds, and every one of which, had he asked information of the Commissioners, they could have given him sound opinions upon.

I have been this evening informed, on undoubted authority, that an epidemic caused by malaria or the leakage of the drains, has again broken out at Croydon; these warnings require the earnest attention of us all, and they are additional reasons why, when no such complaints as are made about the Croydon drainage can be made of the present well-tried system of the Metropolitan Commission, such a sanitary *coup d'État*, as it has been described to be, as the abolition of the present Commission, upon a presumption that a new and untried system is the best, is particularly to be reprehended.

The CHAIRMAN (Mr. MOCATTA, V.P.,) congratulated the meeting on the very able manner in which a subject of vital importance to the health of the metropolis had been brought forward, and hoped that its discussion might elicit valuable opinions to assist in the adoption of a perfect system of

drainage throughout the country. Considering that this great question had been much discussed, and that more experiments had been made in this than in any other country, it was most extraordinary that they had not hitherto been able to arrive at any correct conclusion on the subject.

Mr. GARLING (Fellow) said, that he was much gratified to learn that Mr. Boulnois had a decided objection to the use of pipes for sewers, and also to small sewers generally. Indeed, he considered pipe *sewers* to be both defective and unscientific for the metropolis or for any large town, as the sewers for such places ought to be large enough to enable workmen to enter, and examine and cleanse them. A 12-in. pipe sewer had been lately made in Hatton Garden about 1000 ft. long, intended for the drainage of the houses, as well as for the surface. This size he considered vastly too small, even to carry off the water from the area it was constructed to drain. For in a thunder storm, such as sometimes occurred, and which, therefore, ought to be provided for, sufficient water might fall in one hour to fill such an aperture completely full for a length upwards of three miles long, or about some sixteen times its extent, so that in the event of a stoppage, or the water not running off with sufficient velocity, the consequences might be most serious; and, indeed, there were now repeated complaints of its being the cause of stoppages and overflows in the street in heavy rains, though with very little more than the surface water from the street at present running into it. With reference to this pipe sewer Mr. Garling afterwards observed, that in order to aid its current, it was laid with a fall of $1\frac{1}{4}$ in. in 10 ft., or equal to 55 ft. in a mile, a fall so utterly impracticable on a large scale, that supposing a sewer with such a current to be laid down in Oxford Street (which was about $1\frac{1}{3}$ mile long) and with a water bed 12 ft. deep below the surface of the street at one end, it would be 60 ft. above that surface, or as high as the roofs of the highest houses at the other end. The liability to fracture of pipes used as *sewers* was another objection to the system for the drainage of any large city, from the difficulty of ascertaining the exact place of the defect. The drainage of houses by pipes, assuming a separate drain to each, was less objectionable; but even in house drains a pipe, 6 in. bore, was not ordinarily large enough. He thought there could be no doubt that small drains became stopped up much more frequently than large ones; and he believed that the water ordinary flowing in from closets and sinks was not sufficient to cleanse the small drains commonly used. He knew an instance of a small drain, only 10 ft. long, which was connected with a $4\frac{1}{2}$ in. soldered soil and rain water pipe, being choked up for some months, notwithstanding there was a head of water standing 45 ft. high in the pipe, and when the drain was opened, the water flowed from the opening like a fountain, spouting up seven or eight feet, and yet it had not been able to force its passage through this short length of small drain. Again, there was an absolute necessity for the admission of air into drains or the water would not flow; this may be by an air vent having communication with the external air as high up as possible to avoid smell, or else with the sewer, which latter some might think strange. A very frequent cause of drains being stopped was their being "air-bound," as it was termed; and another evil resulting from this was, that if the air was not allowed to flow into, and escape from the drains by some other way, the water would be drawn out, or forced out of the air traps, as the case might be, and a stench would arise in consequence. If a drain was not as hermetically sealed as it could be by art, except the necessary vents just named, it would always smell; and a frequent defect causing this was the imperfect connection of the soil and rain water pipes with the drain. These pipes should always have proper flanges at the junction bedded in brickwork in cement. One objection to pipe drains was, that in case of a defect it was difficult to discover its exact position without breaking up, perhaps, the entire drain, or great part of it; and therefore a cemented brick drain, or a drain covered with slate or stone, was preferable in that respect; and this remark of course applied equally to pipe *sewers*. With regard to back drainage

he quite agreed with the arguments urged by Mr. Boulnois ; and a further objection was to be found in the fact that what was an area or a back garden at present might hereafter, and perhaps very soon, be built upon, and converted into a house or warehouse ; and, therefore, a drain properly placed there as an external drain at one time, would afterwards become an internal one. Experience had amply shewn the force of this remark, not only in the city, and in places like Oxford Street and Piccadilly, where scarcely a back yard was left, but in the suburbs. Moreover, in back drainage, which was not separate drainage of each house, there would also be a difficulty arising from the opposing interest of the different occupiers, who would constantly object to having the drains in their premises opened to discover defects, from which perhaps their neighbours, and not themselves, might be sufferers. The drainage of every house should be distinct from that of the neighbouring houses—there should be no drain running from one house under the others—in which case the basement at the lowest level might suffer from the defect in the drain of the higher one. A case came to his knowledge in Spencer Street, where a house became almost uninhabitable from the stoppage of the drain in other property which it ran through at the back, and the occupant had made repeated efforts to get it opened, but without success. His appeal to the ground landlord's agent was in vain ; neither the parish authorities, nor the Commissioners of Sewers, he was told, could give him any relief ; and he at last found that his only resource would be to apply to the Court of Chancery. Cases of this kind would constantly occur under the back drainage system, and an immense amount of litigation and inconvenience would ensue. Nearly thirty years ago he had himself advocated in a public Journal many parts of the system recently proposed. He had then declared that no sewerage whatever ought to go into the Thames at any place above Grays ; that on the North side of the river there should be a main sewer—say from Chelsea to Grays Reach ; that at or about Chelsea there should be large tidal reservoirs to be filled at high water, and at about two-thirds ebb this water should be used occasionally for the purpose of flushing the sewers ; and that two large reservoirs should be formed at Grays apart from all dwelling-houses, where the sewerage should be alternately first in one and then in the other, decomposed by chemical means, and removed in barges. Mr. GARLING concluded by repeating his objection to pipe sewers and small drains of all sorts. As a general rule he scarcely knew a small drain that did not choke up, nor a large one that did.

Mr. HAYWOOD, C.E., with reference first to the question of main sewers stated, that he was not a thoroughgoing advocate for brick sewers alone, having himself used and intending still to use pipes ; but he did so only to the extent, to which, in his opinion, pipes might properly be applied, and not to the extent of the telescopic system as it might be termed. And in this he differed with many advocates of the tubular system. He considered that every town should be judged of by its own conditions, and that the main streets of all towns of ordinary size should have sewers large enough for men to enter, the minor streets being left to the judgment of the engineer. It was necessary that sewers, or ducts of some kind, should be provided for carrying off rain water or storm water, house drainage and subsoil drainage : the latter was a most important point, because a dry basement was a most invaluable advantage ; and it was almost as important that a house should be dry, as that it should be free from smells. The question of the best mode of accomplishing all the desired objects was in reality how this could be most economically performed, for it might be done in two or three ways. Some persons advocated three sets of sewers for this purpose. He thought, however, that as a new theory could not be tested for many years, until it was so, a brick sewer, large enough for men to enter, which had been found to answer all the purposes, as being the most simple, was the best. He was convinced that a brick sewer would be found to answer every purpose that could be effected by two or three sets of pipes. Sewers ought to be monumental in their character, and if constructed

in our day, none of us ought to expect to see them replaced by new ones. They ought, indeed, at least, to last for a century, and the sewer in the main street of a town ought never to be broken up till it was worn out. A sewer, whether of brick or pipe, so small that a man could not enter it, should never be employed in such a street. That brick sewers would drain the subsoil effectually might be illustrated by the fact that throughout the city generally they had been able to lower the surface of the water in the gravel as much as six or eight feet; and the basements of many houses, which twenty-five years ago had been almost useless, were now available for the stowage of the most costly materials, such as silks and other goods, and numerous other purposes. He believed the rateable value of the property thus gained was not less than from £20,000. to £30,000. a year. He had now a great number of sewers which had not been opened for years, and which, he believed, never would need to be opened again. With regard to stoppages in pipe sewers, it was stated by their advocates, that it was very easy to obviate them, as they were always found to be preventible stoppages, but where stoppages occurred repeatedly from similar causes they could not be called preventible, but rather constant and unpreventible stoppages, and to that every sewer was subject. Within the last few days one of his pipes had been stopped from end to end. He had built about 120 or 130 pipe sewers, and having used extreme care in their construction he had only had one breakage. With regard to the breakage of pipes, of course that could be obviated, as it would be very easy to make pipes strong enough for all purposes, and the breakage of pipes could not be well alleged as a reason for not using them. He had had two or three trifling stoppages in his pipe sewers, and recently there had been one of a serious nature in Leadenhall Market, a place, the surface of which, of course, could not be broken up with impunity, or without causing great inconvenience. The houses draining into that pipe sewer were occupied by respectable tradesmen, to whom money was not an object, and every appliance had been used in the houses to make both drains and sewer self-acting. The pipe, however, was stopped from end to end, and he could not tell the cause of it, nor whether that cause was preventible or not. He had opened the sewer in three places in a length of 135 ft., but had not broken the pipes. It was doubtful whether that sewer could ever be restored to its integrity again. Referring to one of Mr. Boulnois' diagrams he stated, that when a soft bed of deposited matter once accumulated in a sewer, it became a nucleus which impeded everything passing through it. If he might be permitted to allude to published books, he would refer to a blue book which contained a diagram of the sewer in Holborn, which was within his jurisdiction. In the first place the sewer in this diagram was placed upside down; and further it appeared that a diagram similar to Mr. Boulnois' was shewn to a witness, who was asked two or three extraordinary leading questions, with a view to shew that the brick sewer in Holborn was five or six times the necessary size; because a pipe of the size shewn would carry off all the water of Holborn; but the party had forgotten, or probably did not know, that it was intended to carry off, not only the Holborn water and foul matter, but that of a large area adjacent. There was a curious general advocacy of the tubular system in his blue book, with a vast amount of theorizing on this subject, which, if it proved anything, would prove that a two-in. pipe was large enough for any house of a moderate size. The size, however, of a drain, must be determined by practice, and when the advocates of the very minute system of drains objected that drains, as generally constructed, were double or treble the necessary area required, he, Mr. HAYWOOD, would only reply that, even in determining the sizes of their own drains, they had exceeded the size which their theory pretended to shew was sufficient, and they did so because they said that practically it was necessary to have larger than that given by theory, which Mr. HAYWOOD quite agreed with, and would state, that according to his *practice* a 3 in. drain was not large enough for a house. Ventilation of sewers was absolutely necessary, otherwise they would ventilate themselves

into the houses. The plan of ventilating into the centre of the street, although a bad one was, perhaps, the best that could be adopted at present, as it brought the stream of foul air where it could be the easiest diluted and carried off. With regard to ventilating by the rain water pipes he had found it to answer, although many complaints were made of smell being perceptible in the houses through such mode of ventilation; where the foul air had been conveyed above the chimney-stacks, it appeared in certain conditions of the atmosphere that the effluvium descended again. This was rather a medical question whether it would be better to ventilate in the centre of the street or by the peoples' dwellings, and for himself he was in favour of employing flues; and, he thought that a compulsory measure (such as appeared to be getting fashionable) to make manufacturers allow the use of their flues and tall chimneys for the purpose of ventilating the sewers, might be introduced with advantage, but, he said nothing as to the justice of such a measure. With regard to the drain pipes of Rome and Pompeii he imagined that the Romans collected and applied their fæcal matter to agricultural purposes, as was now done on the continent generally, and that the pipes, of which a specimen was on the table, only carried off the superfluous water of the house. At present one of the great difficulties in Paris was the increasing habit of using water-closets, which had greatly diminished the value of manure, which had brought them hitherto a rental of about £30,000. a year; and, although they abused the Londoners for polluting their river, one of the engineers of Paris had told him, Mr. HAYWOOD, that he was much afraid they would be compelled to do the same, unless the usage of water was restricted. Whatever sized pipes the Romans used to carry off water, it was certain that they used large and flat-bottomed sewers, and the charge of those sewers was deemed a highly important office, as he hoped it would become in this country. Back drainage in this metropolis, he considered, would be fraught with the greatest inconvenience. Where two, three, or four water-closets were close together, one drain might be employed, but to carry the drain through the property of many different occupiers would be a most serious disadvantage. Without interdicting this system in all cases he thought it wrong to lay it down as a general principle, and he quite concurred in the opinions stated by Mr. Garling on this point. The public not seeing the objections to this plan might be carried away by its first cheapness, but the ultimate inconvenience of it would be very great.

Mr. FOWLER (Fellow) proposed an adjournment of the discussion, which was unanimously agreed to.

A vote of thanks to Mr. Boulnois was also carried unanimously.

ON THE DRAINAGE OF BUILDINGS AND STREETS IN THE METROPOLIS.

By W. A. BOULNOIS, Associate.

Being a Discussion, (in continuation of that which took place at the previous Meeting) held at the Ordinary General Meeting of the Royal Institute of British Architects, April 3d, 1854.

The Chairman, Mr. W. S. INMAN, V. P. having impressed on the meeting the value of giving an uninterrupted and impartial hearing to the gentlemen who might address them, Mr. J. J. SCOLES, Hon. Secretary read a communication from Mr. Thomas Morris, architect, to the following effect:—

There is one point in relation to the subject of Metropolitan drainage now brought under the notice of the Institute, to which I would beg your attention.

It is the presumed applicability of syphon sewers to at least the surface drainage, so as to enable the rainwater flowing from high situations to be passed through depressed localities, and finally discharged at the level of some given channel. Thus if the rain falling in the higher environs of London, such as Camden Town, St. John's Wood, and the districts to the north had to be brought into the Thames at Westminster, it would traverse a locality actually lower than the upper or high water surface of the river Thames, and the flooding of such a locality would be the inevitable result with sewers of the ordinary kind whenever the quantity of rain exceeded the capacity of the sewers, which are to be regarded as reservoirs while the floodgates are shut by the action of the tide. To obviate such an inconvenience I suggested some years ago to the Commissioners of Sewers, that after the water had been allowed to find its way down to a suitable level by the simple law of gravitation, means for its further progress should be provided by pipes, similar to those of the water companies, which within limits of height, well known to every architect, would allow of such undulations as the intervening surface might require. Thus a reservoir at the level of Piccadilly might have its eduction pipe carried below the level of St. James' Park and the lowest parts of Westminster, and raised up over the embankment of the river, so as to pour a continuous current into the Thames, at all states of the tide. Intercepting sewers of very considerable length would by this means be wholly obviated, and the enormous expense of their construction avoided. The pipes, it may be mentioned, would not exhaust themselves, but act on the principle of intermitting syphons.

MR. BAZALGETTE, C. E. observed that whilst the professions of Engineering and Architecture were united in many branches, this was especially the case with regard to drainage. The main drainage of a town was the business of the hydraulic engineer, but all the details of house drainage were within the province of the architect, who was necessarily called in when any defect occurred, and expected to provide a remedy. Architects therefore were the best judges as to what systems of house drainage acted well or ill, and the opinions which would be expressed in this discussion would be of great value from their practical nature and the experience of which they were the result. In one remark made by Mr. Boulnois, he could not concur. That gentleman had stated, that "the disagreement of professional men upon the details" of the subject had led to the evils which had occurred. He (Mr. BAZALGETTE) had carefully studied the question, and was of opinion that practical and professional men were not at variance upon it, but that the controversy was between them upon the one hand, and *non-professional* and *non-practical* men upon the other. This was his opinion, though it certainly had for a time been shaken by some of the views which had been put forth in the "Builder," a paper with which he knew some professional men of high repute were connected, and which he regarded as expressing the opinions of architects in general. In the last number of the "Builder," a very fair account of Mr. Boulnois' paper had appeared; it was followed by a statement, headed "Progress of the manufacture of Tubular Drain Pipes," which shewed the great increase in the quantity of drain pipes

annually manufactured since the year 1848, and which was easily explained by the increased attention that had been given to sanitary measures since that period. The article referred to proceeded to state, "it is estimated that in the metropolis about 15,000 houses have been drained with 4 in. tubular drains, and about half as many with 6 in. drains, while upwards of 250 miles of pipe sewers have been laid down in streets." This statement was very incorrect, and he was at a loss to imagine the source from which it had been derived. The facts were that the whole number of houses drained within the last four years amounted to 26,978, of which

4,926	were drained in 1850
8,581	" " 1851
6,271	" " 1852
7,200	" " 1853
Total	26,978

Of this number 20,000 (instead of 7500, as stated in the Builder) were drained with 6 in. pipes. Now although the numbers had been erroneously stated, it was true that 4 in. pipes had been largely used, but it was equally true that they *had failed* to a great extent, and caused a considerable amount of inconvenience. The present Commissioners of Sewers were often called upon to take up 4 in. and lay down 6 in. pipes, and although they did not feel justified in spending the public money in that way, it was being done to a great extent by private individuals. In the same manner the quantity of pipe sewers ("upwards of 250 miles") had been greatly over stated in the article referred to. They had however been extensively employed, and, as the diagrams of Mr. Boulnois proved, they had been often incautiously applied. Without entering upon a crusade against pipe sewers, he would state what the Commissioners of sewers, with his entire concurrence and recommendation, were now doing. During the last year they executed about 22 miles of public brick sewers and 6 miles of pipe sewers, whilst private individuals had executed about 12 miles of brick sewers, and about 85 miles of pipe sewers and drains; making a total of nearly 35 miles of brick sewers, and nearly 92 miles of pipe sewers and drains. This statement would shew that the Commissioners did not advocate any exclusive system, but that under certain circumstances and for minor branch sewers they considered pipe sewers advantageous. The old practice of brick sewers led to a large expenditure, but did not end in failures, nor produce disease, whereas if the use of the modern pipe was carried beyond its proper limits, failures and obstructions occurred, together with an amount of injury to the public health which could not be estimated by pounds, shillings and pence. Some of the new theorists on drainage announced their systems as the most "economical and efficient," but "the cheapest and best house in London" was generally neither the cheapest nor the best, and a system of drainage which might be most expensive in the first instance might be the cheapest in the end. It had been strongly asserted that pipes, or small sewers, were self-cleansing, whereas large or brick sewers had a sluggish flow and became in fact merely elongated cesspools. He could state most positively from experience that this was not the case. It was true that some of the large sewers in London were not self-cleansing, but this was because they were situated in low and flat districts, with their outlets pent up for eight hours at a time by the tide; but from their size they were easily entered and cleansed by workmen, and certainly pipe sewers in the same situations would allow deposit to be made in the same ratio. In fact, taking the best and most modern forms of brick and pipe sewers of the last ten years, and laying them side by side with a tolerable fall under exactly the same circumstances, he could assert that the self-cleansing powers of both would be equal. The representations in Blue Books of brick sewers half filled with deposit were drawn from old sewers without sufficient water flowing through them, many of them now abandoned, and were not fair representations of the existing state of the London sewers.

Mr. BAZALGETTE proceeded to shew by reference to the diagrams that the proportion of the sectional area of the sewage water to the frictional surface of the sewer or drain over which it flowed, in conjunction with the fall, governed the self-cleansing power, and that egg shaped brick sewers of proper dimensions had the advantage over small pipe sewers in this respect, especially in the event of overcharge from storm waters, while they also enabled men to remove the heavy road drift which was so likely to produce stoppages in the latter. All sewers became in time covered internally with a slimy surface, which produced an equality of smoothness between bricks and pipes, and in execution the bottom of a brick sewer could be made more uniformly smooth, and consequently less likely to create an obstruction than a pipe with numerous joints. Comparing 4 in. with 6 in. pipes, Mr. BAZALGETTE applied the theory of the proportion of area to frictional surface, and contended that the scouring power in the former when three parts full would be practically the same as in the latter when half full, and that the 6 in. pipe had an advantage in allowing small substances to pass, which in the smaller pipes would remain and become the nucleus of an obstruction. It had been said that many towns were successfully drained by small pipe sewers. Now he had been directed to visit some of these places, namely, Barnard Castle, Tottenham, Rugby, St. Thomas's Exeter, and Sandgate; and he found that the pipes had been laid down only two or three years and in no case had the drainage been completed, whereas it was obviously necessary to have the experience of a system for at least five to six years before it could be called successful. Again, in those towns which were represented as entirely drained by pipe sewers, he found there was the former system still in use for surface and subsoil drainage, the modern one, of pipes, draining the houses only. At Sandgate two-thirds of the main lines had required to be taken up in consequence of stoppages. When he was there pipes were opened for this reason, and when water from the main was turned on it would not flow through the pipe, and he was surprised to find that the drainage had in fact forced its way through the joints, and had been oozing through the gravelly soil for some time; this was a most serious objection to the use of pipe sewers, as embracing all the evils of the cesspool system. In some of these places they had openings by which the pipes might be inspected, but if the joints were defective, this mode of inspecting, at certain points only, would be useless, and much mischief might be done before the stoppage was discovered. With reference again to the use of small pipes, it was obvious that a larger pipe would allow for a greater amount of sinking in the ground on which it was laid than a smaller pipe. Pipe sewers should therefore be laid larger than the *theoretic* size, to allow for casualties and defects. On the subject of combined back drainage, Mr. BAZALGETTE admitted that there were circumstances in which it might be economical and advantageous, but as a general rule applied to London it would be neither the cheapest nor the best system. The experiments and formulæ of the great philosophers who had studied this subject could not be disregarded, and it was evident from these that a torrent of rain or storm water could not pass through a 6, 9, or 12 inch pipe from a large area. One of the diagrams before the meeting represented the Fleet Sewer, with a sketch of a Locomotive Engine within it as a scale to shew its immense size, but he (Mr. BAZALGETTE) knew that on one occasion a few years ago even that sewer was not large enough to carry off the flood water from Hampstead, &c. Whether separate or combined house drainage were adopted, a sewer in the middle of the street for the surface drainage was essential in all large towns, whatever might suffice from mere country roads, and this point, though it materially affected the question of economy, had been overlooked by the advocates of back drainage. Mr. BAZALGETTE produced a drawing in illustration of the comparison between separate and combined house drainage, and contended that both for economy and efficiency the former system was the better one. In the separate drainage system, each house drain could be probed from the common sewer, without interfering with the adjoining houses in any respect. He further adverted to the difficulty arising from the conflicting interests of different owners, which would prevent the removal of obstructions without the exercise of the legal powers vested in the Commissioners, and likewise referred to the frequent erection of workshops or warehouses in the rear of

houses, which would render back drainage further objectionable. Upon the whole, except in poor outlying districts, where as a matter of economy, or to get rid of the greater nuisance of a cesspool, combined drainage might be introduced, the separate system was the best. He considered that in the case of valuable property, where stoppages in the streets and injury to trade was of the most serious consequence, it was essential to adopt large sewers and the separate system, as that which would interfere the least with the trade and traffic. Mr. Boulnois had dwelt upon the breaking of pipe sewers, but he (Mr. BAZALGETTE) was of opinion that the manufacture of pipes had been greatly improved, and that they might be made strong enough to bear any amount of pressure; although, of course, the cost was increased by the additional thickness. He considered the half socket as the best kind of joint. As to the ventilation of sewers, he found that pipes from them carried above the roofs of houses were liable to the escape of effluvium by leakage, or that the smell was brought down to the windows by eddy currents in certain states of the atmosphere. He believed that a system of ventilation by furnaces, as adopted in mines, would be the best plan; but that in the meantime the present system of ventilation, through gratings into the middle of the street, was the best plan that had been practised. He could not approve of Mr. Boulnois' suggestion of a channel for the surface water beneath the foot-pavement, used in the Corso at Rome, inasmuch as straw and dirt would be washed into it, producing floodings, and causing much trouble and inconvenience.

Mr. BURNELL, C.E., referred to the plan called "en encorbellement," formerly adopted in Paris, of using a small channel worked in the granite curb and under the pavement to carry off the surface water. It had been there found, however, that horses were very liable to slip and break their legs in consequence of these gutters, and the use of them was, therefore, generally discontinued. The Romans confined their proceedings to land drainage and surface water—a description of which was to be found in Columella's, Cato the Elder's, and in Varro's Works "*de re rusticâ*"—any system like the modern sewerage did not exist either at Pompeii, or in any other Roman town. Mr. Boulnois had adverted to the system of sewerage adopted in Paris, and he was sorry to observe that Lord Shaftesbury had praised that system in the House of Lords. The fact however was, that there was no sewerage, in one sense of the word, in that city, and although a few houses and hospitals were said to have their sewage conveyed into the main drains, this practice rendered private parties liable to a heavy penalty, which the Municipality rigidly enforced. The whole extent of the main drains executed in Paris up to the year 1852 was about 90 miles, whereas the Commissioners of Sewers in our own metropolis had executed 35 miles in one year. All the sewers of Paris were large enough to allow a man to enter, the bottoms were segmental, and the minimum fall was about 2 in 1,000. But in Paris there were cesspools beneath *every house*, and although great care and superintendence was exercised in their construction, and excellent materials were used (*meulière and hydraulic lime*), the filtration from the cesspools was so considerable that the well waters had been pronounced by chemists to be unfit for the ordinary purposes of life. Any person who had walked the streets of Paris at night could not have failed to discover that all these cesspools were necessarily opened occasionally. Mr. BURNELL added, that it was too much the practice in Blue Books and with Boards of Health to assume when any convenient phrase or formula had been hit upon that it expressed a fact. Thus the terms "self-cleansing sewers" and "sewers of deposit" had been much used; but a sewer was a passive object, and consequently these expressions were as erroneous in grammar as they were repugnant to common sense. The expressions hill-top and valley water were exposed to the same comment. The Board of Health had laid it down as one of these "formulae" that 80 gallons of water per diem should be allowed as a proper supply to each house, but at Croydon 200 to 500 gallons had been given to each house to carry out the cleansing of these, so called, self-cleansing small tubular drains. Amongst the objections to back drainage one had been overlooked, namely—that the land upon which it was effected became public property, and therefore the introduction of the system would occasion an interference with private rights, to which the people of

England were unaccustomed. Still cases might arise in which from peculiar circumstances back drainage might be desirable; and in the course of his own experience he had been asked by the Commissioners of Sewers to allow another property to be drained through that for which he was concerned; but on another occasion when he proposed back drainage for two houses, and offered to give up their yards to the public, the Commissioners of Sewers refused to allow it.

Mr. T. H. WYATT, V.P., thought the Institute much indebted to Mr. Boulnois for bringing before them with much clearness and ability a subject of so important and practical a nature. Whilst agreeing with almost all his views on this point he (Mr. WYATT) regretted that Mr. Boulnois had thought it necessary to give, as an additional reason for introducing this subject, alleged discontent on the part of some members of the Institution of Civil Engineers, as to the manner in which the summaries of discussions at that society were prepared, and at a want of impartiality on the part of its leading members. Having the honour to be a Member of the Institution of Civil Engineers he (Mr. WYATT) could not allow such an imputation to pass uncontradicted. The subject had been most fully discussed there; and he ventured to assert, that any member who had the courage to express his opinions at those discussions, would have been heard with the most perfect fairness. He believed that the summaries of the proceedings in that society represented faithfully the general views of the different speakers, and it was absurd to suppose that the leading men of that Institution were one atom more "pledged" or prejudiced on a great public question than any member of this Institute. One thing, however, was certain, that the Institute of British Architects was not the place for members of the Engineers' Institution to seek redress for supposed wrongs. The Council of their own body was the only proper channel of appeal. In confirmation of the evils of small pipe drainage Mr. WYATT produced a portion of deposit of *fat* fully $1\frac{1}{2}$ in. thick, which had attached itself to the inner circumference of a 6 in. glazed earthenware pipe, laid about two years ago at St. Luke's Hospital, and completely stopped the free passage of the water and flooded the front area. This deposit was found at a distance of more than 200 ft. from the scullery, where gratings and a trap had been introduced to catch any extraneous matter; with the exception of the sinks and boilers in the scullery nothing drained into these pipes but rain water and the overflow from a large tank at the commencement of the drain. These 6 in. pipes had been taken up and larger ones laid down. Mr. WYATT quite agreed with Mr. Burnell that in matters like that under discussion, it was a frequent error to take stereotyped "dicta" for ascertained facts; and it was a dangerous fashion to circulate cut and dried plans for Drainage, Schools, Churches, and Parsonages, as applicable for *general use*, instead of dealing with *each individual* case as its own circumstances and peculiarities demanded.

Mr. BOULNOIS, Associate, said that his observation at the last meeting was that complaints had been loudly made of the want of proper digests of the opinions expressed at the Institution of Civil Engineers. In making that observation he had merely reiterated what was said week after week in the "Builder."

Mr. WYATT did not assert that Mr. Boulnois had given the opinion as his own, but he had, as it were, taken it for granted, and at any rate had implied that there must be ground for such a charge, otherwise he would not have dwelt on the fact that *here* "they would be able to express their opinion without reservation, and would be reported precisely in proportion to the clearness and accuracy of their remarks." Mr. WYATT held that the Institute of British Architects should not be made a refuge for the destitute, or the disaffected of other societies.

Mr. PAPWORTH, Fellow, inquired what Mr. Bazalgette considered to be the greatest amount of internal pressure to which a 6 in. pipe would be subjected.

Mr. BAZALGETTE did not assume any pressure till a stoppage took place, and then it would depend upon the head of water.

Mr. PAPWORTH then inquired what head of water could be stopped up in a 6 in. pipe?

Mr. BAZALGETTE said that he was not prepared to answer that question from any practical experience.

THE CHAIRMAN suggested that the answer would be given by Mr. Bazalgette's stating the hydraulic proof which he usually put upon drain pipes.

Mr. BAZALGETTE said that hydraulic proof was not applied to the pipes—the actual test to which they were subjected was the external pressure which would crush them. The 6 in. pipes bore the test, but the 15 and 18 in. pipes were so frequently crushed, that until the manufacture was improved the Commissioners would not use any larger than 12 in. diameter. In practice it was found that the 6 in. pipes did not burst, but became stopped up. The external pressure would vary with the depth at which the pipes were laid, and the nature of the soil. He was not aware that pipes were proved by internal pressure, but he knew that when they were first introduced the Board of Health endeavoured to employ them as water mains, and in those cases they burst, and iron pipes were substituted.

In answer to a question from Mr. PAPWORTH, Mr. HAYWOOD, C.E. said, that the gullies in Paris were not trapped, and that a vast quantity of faecal matter passed into the sewers, notwithstanding the Municipal prohibition.

Mr. BURNELL stated that according to the experiments of M. Boussingault there was at least ten times as much ammonia in the atmosphere of Paris as there was in the open country.

Mr. HAYWOOD, gave the particulars of the pipe sewer in Leadenhall Market, which had become stopped up as stated by him at the last meeting. It was 135 feet long and 12 inches in diameter, with a fall of 1 in 120; eight houses drained into it, and these were all fitted with water closets and syphon pans. It was stopped up from end to end, and he was unable to state the cause, and whether it arose from preventible causes or not. No doubt pipes could be made strong enough to bear 200 feet head of water, but the difficulty was to join them securely: and this was the cause of the failure when the Board of Health attempted to employ 2 feet pipes for water mains.

Mr. DOULTON, Visitor, expressed his regret that views of the most opposite nature and carried to the greatest extent in each direction had been expressed by the advocates of the different systems of drainage. Thus they had at one time been told that there was no necessity for brick sewers at all, and at another that it was extremely improper to lay a 12 in. pipe under a carriage way. Again a 4 in. pipe was said to be sufficient for any house drainage, and soon afterwards it was acknowledged that though a 9 in. pipe might be sufficient, a 12 in. pipe would be better. At first, pipes were made exceedingly and injudiciously thin, but now it was contended that a 12 in. pipe should be $1\frac{1}{2}$ in. thick. It appeared to him that the truth lay midway between these extremes. The same remark applied to the diagrams of the drains and sewers. In the Blue Books there were illustrations of brick sewers which would almost prevent any person building a brick sewer again, whilst some of Mr. Boulnois' drawings shewed such representation of defects and stoppages in pipes as would deter any one from laying down a pipe again; indeed he believed these drawings would have produced a very erroneous impression if the apparent facts had not been modified by the remarks of Mr. Haywood and Mr. Bazalgette. The former gentleman had distinctly stated that the use of pipes was a great and most important improvement in drainage operations. The pipe system like all other novelties had energetic supporters, whose enthusiasm might be pardonable; and although pipes had been injudiciously applied, it would be most unscientific to conclude that it was not desirable to use them as sewers. Mr. Boulnois had stated that pipe sewers in the Metropolis had failed, but the remarks he made appeared to be rather in contradiction to the deductions he drew from them. He admitted that pipes had been laid with efficiency, but all that he had said seemed to bear against the introduction of pipes at all (No, No.), at all events, except under special circumstances. Considering that the pipe sewers had been so recently introduced, that they were laid under very disadvantageous circumstances by persons unacquainted with the proper mode,

and that many persons were prejudiced against them as a novelty, he thought it wonderful that there had not been more stoppages than had actually occurred. He attributed those stoppages to the defective way in which the pipes had been laid. Why a concrete foundation should be applied to brick and not to pipe sewers he could not imagine, and if concrete had always been applied to the latter, as it was now, he believed the occasional sinking would have been prevented. Mr. Haywood had very properly stated that pipes could be made of any required strength, and engineers and architects were to blame if they did not stipulate for a proper amount of strength. As soon as the rage for cheapness which existed a year and a half ago had subsided, the pipes were made thicker, but of course the cost was increased in proportion, and it should be borne in mind that excellence in the manufacture was more essential than mere thickness, the thickest pipe not being always the strongest. A 12 in. pipe, 1 in. thick, if well vitrified, would be stronger and better than if its thickness were increased to $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. as the manufacture and burning would be better with the inch thickness. Experience had suggested many improvements in laying the pipes, and the failures bore but a small proportion to the amount of pipes laid. Pipes were now being laid with great prudence and judgment in such a way that they might easily be approached from side entrances and examined, and they were laid in straight lengths and not upon the intricate system adopted two years ago. He did not consider the porous nature of brick to be favourable for the formation of the slimy coating to which some value had been attributed: the vitrified internal surface of the tube would be more certain in its effects. In conclusion, he had observed that however various the theories expressed by different persons, their practice was very similar, inasmuch as those who most strongly advocated the pipe system occasionally used brick sewers, whilst those who advocated brick sewers frequently laid down pipes. This at all events was the result of his own experience and observation.

Mr. FOWLER, Fellow, observed, that Mr. Boulnois had divided the subject into three branches, and that of these the first two had to his mind been satisfactorily disposed of. The third branch of the subject, that of *outfall*, or ultimate disposal of the sewage matter remained for discussion, if the meeting thought it desirable; and he therefore proposed that its consideration should be adjourned till another evening.

Mr. C. H. SMITH, Visitor, said that the remarks which had been made respecting pipes assumed that they were perfect when laid down, whereas he had seen many which had been broken or cracked in transit; and unless actually broken to pieces they were laid down, and, as might have been expected, they had failed, in some cases even before the building was completed. When laid, it would often happen that by imperfect filling in the pressure upon the pipes would not be uniform; but if it were uniform a very thin pipe would bear an enormous pressure. This might be illustrated by the pressure which would be resisted by the small bottles used for pneumatic experiments, and even by a common hen's egg. Pipe drains might fail from the causes he had mentioned, but a brick drain once properly constructed would always remain sound.

Mr. CHRISTOPHER, Fellow, differed with Mr. Bazalgette, as to the greatest amount of deposit being found in old and abandoned sewers. In his own district (Hammersmith) there were two main sewers. One of these which had only been constructed ten years was frequently liable to most serious deposit, and had now been for three months in course of emptying by hand labour, being filled up to two-thirds of its capacity by solid deposit. The other was an older sewer (3 ft. 6 in.) and although there was a large flow of water down it occasionally, it also was being emptied. Mr. Bazalgette's theory as to the scouring power would not apply when a deposit had been formed; and the cleansing he had referred to absorbed the whole local sewer rate of 6d. in the pound, with the exception of a small margin for staff, &c., leaving nothing whatever towards constructing new sewers.

Mr. BAZALGETTE stated that he had intended his remarks to be of general application. The sewers of London for the most part were clean where they had a tolerably good fall, and a moderate quantity

of water passing through them, and if the road drift could not be carried away, they might be kept clear by raking. It was plain that the sewers mentioned by Mr. Christopher, had not sufficient fall in proportion to the quantity of water passing through them to make them self-cleansing, and pipe sewers in the same circumstances would be constantly stopped up. In these instances, the deposit could be removed without disturbing the sewers or breaking up the streets, which would not be the case with pipes.

Mr. Pocock, Fellow, said that in the question of sewers, as in other affairs, only practical men knew how and when to modify the theory, as modified it must be occasionally. The frequent changes and interruptions which had occurred in the proceedings of the bodies having the management of the sewers, even when they were going on satisfactorily, had tended to impede rather than to promote improvements. He proceeded to narrate a case in which he was concerned where he had erected at different periods two sides of a square. In the first instance he applied to the Westminster Commissioners for permission to put in a 3 feet. 6 in. sewer, which he thought large enough to drain thirty-six houses, and seeing no prospect for years of getting any outlet to the South, he proposed to connect this sewer with another to the Northwards; and although certainly this was not the most direct way to the Thames, the Commissioners would not have objected to draining a level surface as he proposed, if it had not been for the opposition of an energetic theorist in the Board who would not listen to the proposition, simply because the new sewer was to the North of the Thames, and therefore as he contended, *must* drain directly towards it. The consequence was that the Board after several years delay spent a considerable sum to lower a 2 ft. 6 in. sewer into which he had to drain his 4 ft. 6 in. sewer (the size insisted on) through an intermediate 1 ft. 6 in. barrel drain. When the reign of this body had come to an end, he erected sixteen houses on the other side of the square, and again proposed a 3 ft. 6 in. sewer, but now nothing would do but a 9 inch pipe! This however he resisted, and was fortified by one of the contractors, who said he would advise him to have cesspools rather than a pipe sewer, and that he would build him a 3 ft. 6 in. sewer for the same cost as the 9 in. and 12 in. pipe sewer to which the Board, were at length willing to accede. He (Mr. Pocock) resisted the board until his tenants complained, when he urged them to complain of him to the Commissioners, and the result was, that they gave way, and he put in the the 3 ft. 6 in. brick sewer. Generally, although a 6 in. pipe would make a very good house drain, it was impossible to use a pipe for a sewer in a public road, with either economy or efficiency. The chief advantage of a pipe was its economy, and this advantage ceased if the pipe was more than 9 inches in diameter, for an 18 inch brick barrel drain was not more expensive than a 12 inch pipe. The frequent complaints against the opening of the public roads for the repairs of sewers, gas, and water pipes sufficiently shewed the tendency of the public mind, and should be a warning to advocates of pipe drainage.

THE CHAIRMAN proposed the thanks of the meeting to Mr. Bazalgette, and the other gentlemen who had given them the benefit of their experience, and moved the further adjournment of the discussion. He stated that the use of drain tiles, and the system of flushing sewers were not modern inventions, that the latter had been found in the ruins of Fountains Abbey, and he described the ingenious system by which, in the time of Cardinal Wolsey, the water of the moat, which surrounded Hampton Court Palace, had been made to flush and carry off the sewerage of the Palace. The original supply of water from Coombe was conducted under the river Thames by an aqueduct, known as the Longford River, and these services were maintained to the present time in perfect operation.

Correction in the Paper read March 20th.

Page 91, line 14, and following lines, should read thus—The thickness of pipes must now be $\frac{1}{2}$ in. for 4 in., $\frac{3}{4}$ in. for 6 in. 1 in. for 9 in., and $1\frac{1}{4}$ in. for 12 in. Beyond this the Commissioners do not permit pipe drains within their jurisdiction, as they have been found to break and cause great damage and expense.

ON THE OPEN SPACES OF OUR METROPOLIS.

By S. ANGELL, Fellow.

Read at an intermediate Ordinary General Meeting of the Royal Institute of British Architects,
May 8th, 1854.

THE somewhat exclusive title of my paper induces a very natural wish on the part of its author, that on examination there may be found in it "more than meets the eye" in the words themselves, though I fear I must not allow myself to indulge in such a consolatory aspiration; for on glancing over our great Metropolitan Chart, I observe but comparatively few important sites left unencumbered by ever expanding bricks and mortar, with the bright exception of "London's silent highway," the majestic Thames!

The immediate purport of this paper is to secure (as far as may be practicable) from future encroachments such open spaces as are now left to us; an attempt which I am the more induced to make by the now daily increasing desire in corporate and parochial bodies to adorn and improve our cities and towns. With this view it has occurred to me that some memoranda culled from the "wise saws" of our old Chronicles, and from the "modern instances" of our living authors, might afford useful information for our guidance; these, with my humble services as your Cicerone, I now offer during half-an-hour's imaginary ramble through the "open spaces of our Metropolis."

Proposing at the outset to take "high ground," I can only regret that I have not a "Mons Capitolinus" for my summit level; in the absence of so crowning an eminence, I thought I could establish a Mons Palatinus on Tower Hill as my starting point, for Fitzstephen says, "on the east of London stands the Palatine Tower," but having consulted Dugdale and Wren, I believe the Palatine Tower referred to must have been at Castle Baynard; we must therefore, I consider, be content with Tower Hill without such lofty pretensions.

The historical associations connected with this spot are of intense interest, but on this occasion I feel that I must confine my remarks to the topographical part of my subject.

Stow describes the site thus, "Tower Hill, sometime a large plot of ground, now greatly straitened by encroachments (unlawfully made and suffered) for gardens and houses." I am inclined to think, however, that these encroachments have since been removed to make way for two of the most successful buildings of the present century, the Trinity House and the Mint, which stand on a very airy and refreshing open breathing spot, which I have always found more free from fog and smoke than any other in the Metropolis. I must not venture into the precincts of the Tower itself; the military engineers having taken possession of the architect's department, any remarks on my part might, perhaps, not be considered coming within the civil bounds of professional etiquette.

Descending from my *pseudo* Palatine, I approach the less aspiring "Fish Street Hill," which is, however, not without its glories, for upon it "was one great house which pertained for some time to Edward the Black Prince;" it formed also the main approach to old London bridge, and it still possesses two of Wren's choicest works, the Monument, and the Church of St. Magnus.

Travelling onward, I will not detain you at St. Mary-at-Hill, St. Dunstan's, Dowgate, or St. Bennet's Hills, nor need I stop on the declivity to the Fleet river (now arched over) by Ludgate on the south line of main thoroughfare, nor on that of the north by Newgate,

"Where from Snow Hill, black steepy torrents run;"

a Charybdis more dreaded by civic navigators than the Scylla-like obstructions of Middle Row; but

even this omnibus engulfing vortex may, I hope, before long be raised to its proper level : we surely need not despair when we see the energetic doings of the London corporation in the immediate vicinity, and know that one of its most influential officers, in his grand and comprehensive plan for a "central city terminus," made one "fell swoop" of this abominable blockade of progress and free communication.

Although I have for many years been acquainted with Saffron Hill, I have not found it to be a *district* possessing many attractions, I will therefore proceed with you to the more verdant and salubrious height of Primrose Hill, (London's "Aventine mount," if you please), once the favorite resort of Londoners. It forms part of a large estate belonging to Eton College, and although its immediate site is, I trust, for ever secured to the public, its once picturesque ascent and its tree crowned summit are now sadly shorn of their former beauties ; bricks and mortar have displaced its verdure, and I fear the most indefatigable botanist would now find great difficulty in discovering a solitary specimen of the flower from which the hill derives its name.

I possess a small view of Primrose Hill taken in its flourishing days by that truly English artist, Thomas Girtin, the fellow student of Turner, and one of the first to lead the way to that perfection to which the art of painting in water colours attained, before the modern style of "relievo" in body colour was introduced.

Our Parks come next in the order of my series. St. James' Park was first formed by Henry VIII, but it appears to have reached its zenith in the reign of Charles II, who is said to have employed a Dr. Morrison upon its embellishment; others claim for Le Notre the merit of laying out the grounds, which contain about 87 acres. Rosamond's pond, the Canal, and the Decoy, have all now disappeared, and though the antiquary may lament their loss, the lovers of the picturesque are perhaps of opinion, that the present appearance of the park is fully as agreeable as it could have been in the days of the "Merrie Monarch," Nell Gwynn, Killigrew, and His Grace of Buckingham.

The adjacent Green Park was originally called Upper St. James' Park ; it contains about 56 acres but was formerly larger, a portion having been taken off in the reign of George III, to enlarge the gardens of Buckingham House. On the east side there are some noble mansions. Spencer house (the work of Vardy), one of our palatial gems ; Stafford House, and Bridgewater House. I regret I cannot extend my admiration to the Royal buildings on the opposite boundary of this park.

Hyde Park is stated to have been enclosed with brick walls in the time of Charles II. It was formerly a deer park, in which the French ambassador hunted with Edward VI. in 1550. It has always been celebrated for its drives and promenades. Pepys relates, that he used to ride there in his coach, and that on one occasion he met the Duke of York, "who did eye my wife mightily." If the gossiping Secretary could see Hyde Park at the present day, I wonder what his exclamations would be upon the Colossus from the Monte Cavallo ! and on the Cavallo perched upon the Arco Colosso !

George IV, when Regent, gave us an additional Metropolitan lung in the park named after his title, and we are indebted to the skill of the late Mr. Nash for its general arrangement and plan ; it contains with its surrounding terraces, altogether about 450 acres.

At the eastern extremity of London we have Victoria Park, (another modern creation), and on my list I next find Whetstone Park ; but as I am not acquainted with any beauties in it to describe, nor the number of acres to enumerate, I will pass on to Battersea Park, which can scarcely yet be considered *in esse* ; while Highbury Park, which I fear is still *in nubibus*, I have not ventured to include in my catalogue.

Our public Gardens may not inappropriately follow our Parks. Kensington Gardens are "par

excellence" *the Gardens* of the Metropolis; they originally contained only 26 acres, to which Queen Anne added 30, and George the Second's Queen 300, making altogether 356 acres, where—

"The dames of Britain oft in crowds repair
To gravel walks and unpolluted air,
Here while the town in damps and darkness lies,
They breathe in sunshine, and see azure skies."

Spring Gardens, which in the time of Charles I and II, had a bathing pond, pheasant yard, and bowling green, in the reign of Victoria, present no other rural feature than the name.

Privy Gardens have in like manner undergone a change, and bricks and mortar have now invaded the fair "three and a quarter acres," which Pepys describes as having been laid out in his time in sixteen compartments, having a standing statue in the centre of each.

The Temple Gardens are fortunately still preserved to us in nearly all their integrity represented in Canaletto's views; long, long, may they continue with their green plots, and flowers, and fountains "sparkling in the sun," and in the sweet words of Elia, "So may the fresh coloured and cleanly nursery maid, who, by leave, airs her playful charge in your stately gardens, drop her prettiest blushing curtsy as ye pass, reductive of juvenescent emotion."

Gray's Inn Gardens are also well preserved, and I expect are not very far different from what they were in the days of the Spectator and the Tatler, saving the encroachments of Verulam and Raymond's Buildings. Lord Bacon is said to have planted some of the trees, and Howell, writing from Venice in 1621, to Mr. Richard Altham, in Gray's Inn, says, "I would I had you here (in Venice), with a wish, and you would not desire in haste to be at Gray's Inn, though I hold your walks to be the pleasantest place about London, and that you have there the choicest society." Mr. Cunningham, in his instructive "Hand-book of London" observes, that the Gardens in Charles the Second's time possessed an uninterrupted view towards Highgate and Hampstead—"We are stepping westward," says Mr. Cunningham—"Moorfields gave way to Gray's Inn, Gray's Inn to the Mall in St. James' Park; the Mall to the Ring, and the Ring to the Long Walk in Kensington Gardens."

Hatton Garden's flourishing days seem to have departed in Evelyn's time; for the good knight describes the foundations being laid out "for a longe streete and buildings designed for a little towne, lately an ample garden."

Many of the City Companies' Halls have gardens attached to them, the principal of which are those belonging to Drapers' Hall, in Throgmorton Street, which contain nearly two acres. These gardens are interesting to the London antiquary from the circumstances so minutely related by Stow, of the arbitrary proceedings in 1541, of Thomas Cromwell, Earl of Essex. Stow's father had a garden there, of half of which the Earl deprived him; he tells us, "no warning was given him, or other answer, when he spake to the surveyors of that work, but that their master, Sir Thomas, commanded them so to do; no man durst go to argue the matter, but each man lost his land, and my father paid his whole rent, which was 6s. 6d. the year, for that half which was left." Old Stow adds, "Thus much of my own knowledge have I thought good to note, that the sudden rising of some men causeth them to forget themselves." Ward, in his "London Spy," commends these gardens as a fashionable promenade "an hour before dinner time." In 1552, we find the following regulations for these gardens—"The Gardyner to suffer no strangers to bowle, in case there be any of the Company disposed to bowle in the place; neither to take erbyes or fruite."

In our own days, we have our Zoological and Botanical Gardens, richly compensating us for the loss of the Bear Garden in Bankside, the Dog and Duck in St. George's Fields, and the Cock Pit at Whitehall.

The Fields of London as well as our Gardens require some notice, and although it is complained that we have now "no more fields," we have still the open spaces, if not "the daisy'd banks embroidered o'er." Of these, for extent, Lincoln's Inn Fields claim the first notice. The earliest accounts describe them as the resort of bad characters, and as being used for breaking in horses.

In the *Daily Journal* 9th July, 1735, we find that "the plan for beautifying Lincoln's Inn Fields is now before His Grace the Duke of Newcastle; there are to be four iron gates, one at each corner, and dwarf walls with iron palisades, this plan has been agreed to by the inhabitants."

In the reign of Charles II, Thomas Sadler, a notorious thief, who had the supreme daring to steal the mace and purse of Lord Chancellor Finch, made a mock procession with his booty at night through Lincoln's Inn Fields; and in our own days mobs have assembled there to agitate questions of supposed political grievances.

On the south side of the Square is the College of Surgeons, originally the work of Dance, but since altered and enlarged by Sir Charles Barry. On the west, stand Newcastle House, Powis House, and Lindsey House, the works of Inigo Jones; on the north side, is the Museum (formerly the residence) of Sir John Soane, a real lover and munificent patron of art, whose liberal feelings towards this Institute must always be gratefully remembered.

The east side of Lincoln's Inn Fields, which was formerly separated from the adjoining gardens by a low wall, now presents a successful group of buildings in the mediæval style, the first important work of a young friend of mine, who appears determined that the name of Hardwick shall continue to be associated with success in art, and worthy of the recent honour so deservedly bestowed by this Institute on his esteemed father. We have all heard that the area of Lincoln's Inn Fields is equal to the base of the great Pyramid. I must honestly confess myself no advocate for covering this most noble "of our open spaces" with buildings, however useful or ornamental they may be; though we appear by no means anxious to avail ourselves of this our largest "open space," by providing good access to it.

Moorfields, within my own recollection, were bounded on the south side by a long gloomy foreign looking building with pavillions at the ends enclosed by a high brick wall, with entrance piers surmounted by those master pieces of Cibber, so characteristic of the abode of which they appeared to form a part. We must all rejoice that this Hospital has been removed to a more open and spacious situation in St. George's Fields, where, thanks to the philanthropy and common sense of the age, the lunatic is now treated with skill and kindness, and that immediately opposite to the site of the former repulsive fabric, there now stands a building devoted to the purposes of literature and science.

Casting a glance only at Goodman's Fields, Spital Fields, Tothill Fields, Spa Fields, and passing through Bartholomew Close, we enter that celebrated field, where, in days of yore, a Lord Mayor of London won his spurs, and William Walworth's unerring dagger became the heraldic emblem of London's chivalry.

The site of Smithfield is as full of historical interest as Tower Hill itself, and its reminiscences are about as painful; whatever may be its future destination, I feel confident that those who have the control will devote it to the purposes best suited to the requirements of the age, with a due regard to the interests of the adjoining Royal Hospital of St. Bartholomew.

The Squares of London are well deserving a few words of notice; they form one of the most agreeable features of our Metropolis, and I am not acquainted with any Continental City in which they are equalled in point of number or in general arrangement.

St. James' Square, formed in 1676, has always been inhabited by the gentry and nobility. There are some noble mansions in it—the residence of our noble President, Norfolk House by

Brettingham, Lichfield House by Athenian Stuart, and London House by the present accomplished Professor of Architecture at the Royal Academy.

Grosvenor Square, so called after Sir Richard Grosvenor who died in 1732, also possesses many noble mansions, and has more of an aristocratic air than any other of our London Squares. An equestrian statue of George III., formerly in the centre, has disappeared. Portman Square, commenced in 1764, was not completed till twenty years afterwards. Manchester Square was formed in 1776. Cavendish Square was laid out in 1718; the North side, which was reserved for the residence of the Duke of Chandos, has been since built over, the two centre houses being, I believe, from the designs of Sir William Chambers. On the west side stands Harcourt house, inhabited by the Duke of Portland, which presents with its high court walls and "porte-cochère," more of the appearance of a Parisian mansion than any other house in London. The equestrian statue in the centre is that of the Duke of Cumberland, and on the South side there has lately been placed a statue of the lamented Lord George Bentinck.

Hanover Square, named in honour of George I. was formed about 1718. This Square in connection with George Street has always struck me as one of the most scenic architectural displays that London presents; the street expanding towards the square, the unique and elegant style of the surrounding mansions, the judicious mixture of red brick and stone, Chantrey's statue and the successful ecclesiastical work of James altogether produce the most agreeable effect.

Leicester Square was built about 1635. On the North side was formerly the residence of the Prince of Wales, father of George III. Hogarth, Sir Joshua Reynolds, and the celebrated John Hunter, the surgeon, dwelt here; and in St. Martin's Street adjoining, the immortal Newton lived!

I do not know whether we may consider this Square as one of the lungs of St. Martin's parish, if it is, I fear its respiratory action must be somewhat impeded by the large obstruction now formed in its centre.

I cannot take leave of this Square without a passing word of praise on the clever and original design of the Panopticon, the successful work of a talented young member of this Institute.

Trafalgar Square claims a front rank in our list of "open spaces," more particularly when putting forth its claim, as "the finest site in Europe." When the decorative accompaniments to Nelson's column are completed, and George IV. is allowed to have an equestrian companion on the now vacant pedestal, we may perhaps be better enabled to decide upon the merits of Trafalgar Square.

Of the Piazza proper of Covent Garden, I may remark that it was designed by Inigo Jones in 1631, with the Arcade as at present on the North and East sides, the Church on the West, and the wall of Bedford house on the South—the mansion was taken down in 1704; next this wall was a grove of trees where the market used to be held. In the centre of the Square was placed a column with a dial.

Gay has well described the Church and the Square in these expressive lines:—

"Where Covent Garden's famous Temple stands,
That boasts the work of Jones' immortal hands,
Columns with plain magnificence appear,
And graceful porches lead along the Square."

The present market was built in 1830, our brother member, Mr. Fowler, being the architect.

I must not weary you by a tour through the other squares of the Metropolis, in Belgravia, Tyburnia, and Westminster. Bloomsbury, which the Grand Duke Cosmo was taken to see as one of the wonders of England, Finsbury and the Minories, all put in a claim for their "open quadrangular

spaces," and in that gigantic effort of Post Office literature, the Directory, I am told that more than 100 will be found enumerated. I am sure, therefore, I shall stand excused for having presented a selection only.

Of the Greens in London, Clerkenwell and Bethnal are the only ones that now occur to me. Strype tells us that a mansion was built on the latter in 1570, by John Thorpe, the architect of Holland House.

Of Yards we possess several, but I will only name the two Palace yards, Scotland yard, and Whitehall yard.

The Tenter Ground and the Artillery Ground are both good sized "open spaces;" I believe the latter to be the only one where the military ardour of the citizens has a field for active exercise.

The Markets of London, I fear, will not strictly come under the title of my paper as "open spaces," but I cannot altogether pass them over; however disposed I might feel to place them in the condemned schedule, the great improvements which are now making by the Corporation of London, under the excellent judgment of their architect, in the fields of Copenhagen and on the shores of Billingsgate induce me to look forward to an early period, when the shambles of Newgate Street shall give place to an extension of the paths of literature of Paternoster, and the hides and the beeves, and the fish, the flesh and the fowl of Leadenhall shall find a more suitable abode, and resign their present site to the enlargement of thoroughfares, and the increase of that important branch of industry and commerce, our Colonial market!

There is one attractive feature in most Continental cities, which unfortunately is entirely wanting in London. I allude to planted avenues of approach, or surrounding Boulevards. What can be more agreeable and refreshing when escaping from the town's noisy streets than the shady repose of a leafy avenue? the effect both on entering and on departing is materially affected by the character of the thoroughfare, I trust therefore the day is not far distant, when in direct contrast to our New Road and City Road, Curtain Road and New Cut, we may have a spacious open VIA REGGIA from the Regent's Park to princely Hampstead, in accordance with the noble design of the accomplished Professor of Architecture of the Royal Academy.

My brother architects will readily recal to their minds those lines of Spratt's, introduced in the Parentalia:—

"Fountains and trees our wearied pride do please,
Even in the midst of gilded palaces!
And in our towns that prospect gives delight
Which opens round the country to our sight."

I fear by this time your Cicerone—like many others of his class—must have nearly exhausted your patience. May I ask you kindly to extend it to me for a very short period, while I detain you with the most important part of my subject, "St. Paul's Church Yard."

Our indefatigable antiquaries have put in a claim for a temple to Diana on this spot, but Wren, who had a good opportunity of forming a judgment when preparing his foundations, discovered no corroborative proof in support of Apollo or Diana; Sir Christopher's own words are—"I must assert, that having changed all the foundations of St. Paul's, and upon that occasion rummaged all the ground thereabouts, and being very desirous to find some footstep of such a temple, I could not discover any; and therefore can give no more credit to Diana than to Apollo." And in the excavations for Messrs. Cooks' warehouse, no fragments of great antiquity were found, excepting the Runic stone, a cast of which our brother member, Mr. Knowles, has kindly presented to the Institute, and several short pieces of deer's horns—A Stukeley would immediately connect these with a fane to the Goddess,

and rear his temple with the same facility as a Paleologist constructs his gigantic monsters from a dental fragment, or a solitary vertebra. I should much prefer some columnar shafts, and Ionic volutes to these pieces of deer's horns, which I think may possibly have been intended to form rosaries for paternosters. A statue however of a Roman soldier of the 2nd legion was found near the neighbouring Ludgate, and as the topographical inscription under the sculptured boy in the adjoining Pannier Alley informs us,

“That if you search all London round,
Still this you'll find the highest ground.”

—it may be reasonably inferred that the site of St. Paul's Church Yard formed an important part of Roman London.

I may here perhaps be allowed to remark, that I doubt whether we have ever justly appreciated the importance and size of the Metropolis in its Roman days; the numerous fragments of mosaic pavement that have been found, the Hypocaust at the Coal Exchange in Lower Thames Street, the numerous specimens of pottery and coins, and the great accumulation of debris, all tend to shew that very considerable buildings must at that period have occupied sites now covered by far less substantial erections.

Stow speaks of a patent of Henry I., granting to the Bishop so much of the Castle Wall, (Castle Baynard of the present day) as should be needful to make the wall of the church, (St. Paul's) and so much as should suffice to make a wall without the way on the north side; and in the time of Edward I., there appears to have been a presentment in the matter of the grant, when it was contended that the whole “soil between the gate called St. Augustin's Gate near the said church and the gate on the West part of the said church towards Ludgate, is High Street, and the King's highway, whereof a great part by the raising of the wall at the East, and the building of houses is now enclosed, and the King's High Street much streightened to the great damage of the whole city.” Our ancestors therefore appear to have been fully alive to the importance of “open spaces,” and I only regret they were not more successful in resisting those very encroachments which are now only in part cleared away, and to which I shall presently more particularly allude.

My acquaintance with “black letter” literature is too limited to enable me to give you any further account of St. Paul's Churchyard previous to the time of Henry III., in whose reign we learn from Stow, that leave was granted by letters patent to the Bishop, to enclose the churchyard of the said cathedral church and the precinct with a stone wall round about. On the North side of the church was originally a great cloister environing a plot of ground, “of old time called Pardon Churchyard,” about which was a richly painted “Dance of Death;” and “over the East side of the cloister was a fair library, and in the midst of the churchyard was also a fair chapel, founded by Gilbert Becket, port-grave and principal magistrate of this city in the reign of King Stephen.”

“In the year 1549 the said chapel by commandment of the Duke of Somerset was begun to be pulled down, with the whole cloister, the Dance of Death, the tombs and monuments, so that nothing thereof was left but the bare plot of ground, which is since converted into a garden for the petty canons.”

Of Paul's Cross, one of the most interesting objects in London history, Stow tells us, that it was “about the midst” of the churchyard, (it is shown in old engravings at the North East corner); he describes it “as a pulpit cross of timber, mounted upon steps of stone, and covered with lead, in which are sermons preached by learned divines every Sunday in the forenoon; the very antiquity of which cross is to me unknown.”

In this part also (the North East angle) was the Campanile, Clochier, or Bell House; Stow describes it as "four square, built of stone, and in the same a most strong frame of timber with four bells, the greatest I have heard—these were called Jesus' bells, and belonged to Jesus Chapel—the same had a great spire of timber covered with lead, with the image of St. Paul on the top, but was pulled down by Sir Miles Partridge in the reign of Henry VIII. The common speech then was, that he did set a hundred pounds upon a cast at dice against it, and so won the said Clochiard and bells of the King."

Our chronicler continues—"then was there on the North side of this churchyard a large charnel house for the bones of the dead, and over it a chapel of an old foundation;" these bones, amounting to more than 1000 cart loads, were removed to "Finsbery field"—(extra-mural interment therefore was considered necessary in those days) and there laid on a moorish ground, which in a short time being raised by the soilage of the city upon them, was able to bear three windmills, (Windmill Street, Moorfields, is no doubt formed upon the spot). The chapel and charnel were converted into dwelling houses, warehouses, and sheds before them, for stationers, in place of the tombs."

I am inclined to think the removal from the charnel house above referred to could not have taken place till after 1552, for we find the pious Latimer, on the 3rd Sunday in Advent in that year, complaining in his sermon—"I do much marvel that London being so rich a city hath not a burial place without, for no doubt it is an unwholesome thing to bury within the city, specially at such a time when there is great sickness, so that many die together. I think verily that many a man taketh his death in Paul's Churchyard, and this I speak of experience, for I myself when I have been there in some mornings to hear the sermons, have felt such an ill-favoured unwholesome savour, that I was the worse for it a great while after, and I think no less but it be the occasion of much sickness and diseases." That Wren also strongly recommended extra-mural interments, appears from his letter to his brother commissioner for building fifty additional churches in London.

Latimer is said to have preached his sermon of the Plough in "the Shrouds" which appears to have been a sort of covered gallery attached to the walls of the cathedral, in which probably the more distinguished portion of the congregation used commonly to be seated, and where the preacher also sometimes took his station when the weather was coarse.

On the North West side of the churchyard, Stow describes the Bishop's Palace wherein "divers Kings have been lodged, and great household hath been kept," and on the South side was the Chapter House, a beautiful piece of work, (shown in Hollar's View) built about the reign of Edward III., but in Stow's time defaced by means of licences granted first to build "low sheds" and then, "high houses."

In Pepys' time, St. Paul's Churchyard appears to have been as much famed for booksellers' shops as Paternoster Row is at the present time, and at the great fire the losses were considerable, "£ 150,000 worth, and all the great booksellers almost undone." Vast stores of books were consumed in the vaults of St. Faith, where according to Evelyn they continued to burn for a week. This is the subterranean church, to which in our early days we attach a mysterious and fabulous history, and to which the lines apply,

" This church needs no repair at all,
For Faith's defended by St. Paul."

From the survey taken by order of the corporation soon after the great fire, for the use of the commissioners of the streets, lanes, &c., (published by Vertue in 1723), we can form a very fair idea of the general state of St. Paul's Churchyard at that period.

St. Paul's school is shown on the plan with an altered "give and take" line of frontage, extending to the North East angle, where according to Treswell's plan, (made as early as 1585) formerly stood St. Paul's gate, leading to Chepe, close to which was the church of St. Michael le Quern, with the "little conduit" at the East end of it, and to the North, Blow Bladder Street, conducting to Newgate market. The houses fronting East to Cheapside, were called Jackanapes Row. The North and South boundaries of the churchyard, which have been described as "the string and the bow," appear with trifling alterations to have been nearly similar to the boundaries as they existed previous to the late improvements connected with Cannon Street, the line extending in a curve from Paul's Chain up to the West end of Watling Street, where formerly was situate "St. Austin's Gate."

The plan of old St. Pauls is very clearly laid down in the city plan with the church of St. Gregory and the Convocation house on the South side. I must not however encroach further upon your time with any account of the old or of the present St. Paul's; those buildings would of themselves afford abundant interesting matter for a separate paper, and I therefore commend them with every confidence for that purpose to the able and learned pen of the present estimable architect Custode.

I must detain you for a few moments at Sir Christopher Wren's drawing office, and at a building which certainly cannot be well overlooked, the Colossal warehouse, lately erected by our brother member, Mr. Knowles, for Messrs. Cook.

The great architect's drawing office was on the South side; it now forms part of St. Paul's Coffee house; there is no mistaking it—from the balcony in front there is a most superb view of the West front, of which I was delighted to see a most successful representation at the Exhibition of the Royal Academy, the performance of a rising young architect, whose distinguished father has shown his profound veneration for Wren in the most elegant testimonial ever produced by kindred genius!

The Colossal warehouse, I think you will agree with me, is fully entitled to that appellation, when I state that its length is 171 feet, average depth 74 feet, height 90 feet, and the cubical contents one million one hundred thousand and fifty feet! I was extremely glad to have the aid of steam power in lifting me to its summit, and the assistance of a guide to point out its extent; but I know not whether my astonishment at its size was not surpassed, when the architect informed me of the rapidity with which the work had been executed, *ninety days only* having elapsed from the time that the first brick was laid, to the period that Messrs. Cook were enabled to resume their business.

To refer again for a moment to "days of old," I will adopt Mr. Knowles' own account of the Runic monument discovered in the excavations for this building.

Mr. Knowles says:—"During the progress of the excavation, nothing very remarkable was discovered, with the exception of a Danish grave stone, which was found at a depth of twenty feet below the general surface level: it bears upon one of its sides a Runic inscription, which on the authority of the Royal Society of Northern Antiquaries, may be read thus, KINA caused this stone to be laid over, or in memory of, TUKI. The date of this relic is about A.D. 1000, and it is said to be the only Runic monument known to have been discovered in London: by the side of the stone were laid the remains of a skeleton, and in the immediate neighbourhood were found a great number of deer's horns cut into short pieces."

Having thus given you a rough outline, and I fear a very indistinct one of the former and of the present state of St. Paul's Churchyard, I will venture a few words upon a most interesting document in the Soane collection. It is a sketch plan for laying out the area round the Cathedral, and as there is the hand writing of Sir Christopher at the corner of the drawing, without doubt it is by Wren himself! Sir Christopher's idea appears to have been, to make the area as nearly

symmetrical as the site would admit, and to form a continuous portico in front of the houses, interrupted only by the openings to the lines of streets. At the west end, we can almost fancy that Sir Christopher had Bernini's great work in view. Sir Christopher had been introduced to Bernini at Paris, and he was so much pleased with his design for the Louvre, that he states, "Bernini's design for the Louvre, I would have given my skin for; but the old reserved Italian gave me but a few minutes view." At the western extremity of his plan, Wren has designed a circular building of some importance, the purpose of which I cannot clearly define, it appears large enough for a chapter house, but I have no doubt, that the ingenuity of some of our numerous admirers of Wren will be able to give a satisfactory solution of the difficulty. In the catalogue of 64 original drawings by Wren relating to St. Paul's now at All Souls' College, Oxford, I can find no plan which appears to resemble the one just described. To compare this most admirable plan with the wretched irregular "string and bow" space of the present Church-yard, only increases our regret, that Sir Christopher in this instance, as well as in his noble plan for rebuilding London, was obliged to give way to notions of false economy, and a mistaken idea of maintaining private rights; his plan, if executed, would have rendered London the finest city in the world. I fear no such unqualified pretensions can be made by it in its present condition.

A century has now nearly elapsed since Gwynn produced his admirable work, "London and Westminster improved;" his volume has been a guide and a text book at Whitehall as well as at Guildhall; many of his suggestions have been adopted with complete success, and I trust they may be quickly succeeded by others, for a golden opportunity, consequent upon the recently formed opening to Cannon Street, now presents itself for crowning the successful labors of the Improvement Committee of the City of London in this direction, in a manner which will confer upon them the gratitude and admiration of the whole metropolis; indeed, I may extend it to the whole civilized world, for where in the whole territory of civilization is the individual who has not heard of this "noblest of Protestant temples?"

I am very desirous that every credit should be given to that body of gentlemen, the Improvement Committee, for the satisfactory manner in which they execute the large and important matters which are intrusted to them; what has hitherto been done by them, particularly of late, is admirable. I well know the responsibilities they have undertaken, the numerous applications they have from all parties and from all quarters, and beyond all these, I am aware of the enormous sums that are required for carrying into effect great lines of new and improved thoroughfares through dense and crowded districts. Many here present, I have no doubt, will be somewhat surprised to hear that the cost to the Corporation of London for the Cannon Street improvement, after realizing by sale the large ground rents derivable from the new and improved frontages, will amount to more than half a million sterling!

It may be all very well for some ingenious theorist in "ways and means," to say to the Corporation, "Sometime since, you succeeded in removing Crooked Lane from its former position in East Cheap to a new situation in Gresham Street West, what now more easy than to make a communication between Vintry and Portsoken, or to carry a line from St. Andrew in the Wardrobe to St. Margaret Pattens?" but, gentlemen, unless the sinews of improvement are forthcoming, all these valuable suggestions are of no avail; it is a popular fallacy to suppose that these improved lines of public thoroughfare are remunerative to their promoters, for when the sum total of the different interests, the freeholders, the leaseholders, sometimes four or five deep, the tenants in possession, the good wills, the loss of trade, the removal, and the fixtures, with 10 per cent. in addition for compulsory sale, the references, the law charges, not omitting the surveyor's charges; when, I repeat, all these items are added together, a result is produced truly astounding in its amount, and quite sufficient, I can assure you, to

test the financial skill of the Committee I have before referred to, whose great talent and ingenuity in the important matter of raising the supplies are not merely confined to the inhabitants of London, but are acknowledged, I regret I cannot say *gratefully* acknowledged, by every ratepayer within a 20 miles radius of the Post Office.

I would venture to submit to the Authorities, that there is a loftier point than a mere financial one, from which we should look upon this question. Although it may be a matter involving some fifty or sixty thousand pounds, that amount ought not to deter us from the proper completion of the most important civic improvement of modern times. Should a dry question of cost in London, of all cities in the world, prevent its citizens from displaying the finest specimen of Italian architecture the metropolis can boast of? Shall we allow it to be handed down to posterity, that the Londoners are unable to appreciate fine works of art, and noble triumphs of genius? Are we those citizens who aspire to the title of "merchant princes," and shall we yet permit our continental allies and rivals to leave us far behind, in supplying proper encouragement and resources to those who have the talent and ability to give an appropriate and magnificent character to the architecture of their country? I would implore the Authorities to put aside the paltry *£. s. d.* question, and I would appeal to them as men of *taste* as well as men of *business*. Let me urge them to this, adapting for the occasion the words of a city poet,*

" That *they* may add to London's dignity,
And London's dignity may add to *theirs*."

They have the advantage of being assisted by a member of this body, an architect whom we all esteem, who on several occasions has successfully entwined to their delight, the blossoms of art with the fruits of commerce; and knowing well their praise-worthy veneration for precedents, I would recall to their recollection, that a few years since, when their emporium of commerce was rebuilt, they voluntarily sacrificed the site of Bank Buildings, a plot most singularly similar in size and form to the one whose freedom I am now unworthily advocating, and only differing from it in its *greater* local value. What they voluntarily acceded to their *Exchange*, surely, they cannot refuse to their *Cathedral*! And the honor they so worthily paid to their distinguished architect in the 19th, they cannot for one moment refuse to the memory of London's great architect of the 17th century!

As the day of the triumphal opening of the new street is shortly approaching, may I most respectfully take the liberty of suggesting, that on that auspicious occasion the Authorities should allow the encumbering hoarding to be removed, and the site fairly levelled?—they would then display to their applauding fellow citizens a sight by far exceeding all the elaborate pageants from the days of Walworth to those of Sidney!

I have every confidence that this appeal to the Corporation of London will not be made in vain, and that that Body on their part, and you my brother members of this Institute on yours, will generously step forward to effect the great national objects we have in view—the preservation of an open space through which the light of glorious day may shine upon the most noble Protestant temple in the world! and the dedication of a statue to testify our gratitude to its architect, that great and good man, Sir Christopher Wren!

Mr. HARDWICK, Fellow, said that he must claim it as his special duty to move the thanks of the Institute to Mr. Angell for the admirable paper just read. No one had been more intimately associated with that gentleman than he had for a period of nearly forty years, during which mutual friendship

* George Peel, The Pageant, 1585.

and esteem had existed between them. He was quite sure the meeting would unite with him in expressing their sense of the attention Mr. Angell had paid to the important subject of his paper. Although they must all feel that in laying out a new city it was most important to provide open spaces, it was much more important to preserve those which existed in an old city like London; and when an opportunity occurred of leaving unencumbered such a spot of open ground as that at the south-east of St. Paul's, so as to expose to view most favourably the magnificent structure of which they were justly proud, it was essential to embrace it. Mr. Angell had been peculiarly happy in his allusion to the unfortunate attempts which had been made to fill up some of the open spaces of London. In reference to Leicester Square, they must all feel that what had been done was a perfect failure, and he would rather see it with its broken shabby railing, and its dirty trees and grass, than in its present state, however interesting the building with its contents which now occupied it. He should, moreover, be extremely sorry to see Lincoln's Inn Fields covered with buildings. If the space between that spot and the Strand were cleared away, it would afford a magnificent site for the proposed new Law Courts, without infringing on "our vacant spaces."

The CHAIRMAN, Mr. T. H. WYATT, V.P., said it was not the first time Mr. Angell had instructed and pleased the members attending the evening meetings by his remarks, and they would, no doubt, recollect his interesting paper on the life, the genius, and the works of Vignola. Mr. Angell had expressed his regret at the departure of the primroses from Primrose Hill, but he had managed to bestrew his paper with many charming flowers.

Mr. TITE, Fellow, considered that Mr. Angell had nearly exhausted the subject in his own excellent observations, and he could only most cordially second the motion of his friend Mr. Hardwick. Quoting from memory, he believed that one of the Odes of Horace commenced with the remark, that "the town in its mighty buildings treads so heavily upon the country, that there soon will not be an acre for the plough to work upon," and he was afraid that this was really coming to pass in London. The worthy alderman now present had seen many changes, and known many, many acres covered: the fact that many fields which had been covered by the modern Babel in the recollection even of young men, and the idea of the plough yielding to the palaces of the present day became strongly impressed upon the mind, and the preservation of all existing open spaces, merely for breathing room, was therefore strongly to be inculcated. With regard to the space at the south-east end of St. Paul's, he would not pretend that it was essential for the mere purposes of health—it would be idle to seek it or to ask it on such grounds—but in a meeting of architects like the present, its importance could not be lost sight of. He fully understood the commercial value of the site, and the difficulty the Corporation would find in replacing the £50,000. or the £60,000. it might cost; but he believed they would appreciate the feeling of architects, and the immense gain, in an architectural sense, the city derived from the marvellous view which had been afforded of its great national work—a gain far greater than the mere £60,000., or any sum which could be put into the scale against it. He believed it was only necessary to appeal to the good taste of the citizens of London, and their appreciation of the magnificent view which had been thus accidentally opened, and that they would do their best to preserve it. They would thus be enabled to convince foreigners, that there was something in London worth coming to see. London was formerly a city of churches and monasteries, it then became a city of merchants' dwelling places, it might now be said to be a city of counting-houses; it was important therefore to preserve, if possible, some memorial of its former more open state. They could not boast in London of the fine architectural groupings of Berlin, Munich, Paris, and Rome, and whilst in that respect they could offer so little to the wondering stranger, appalled by the bustle of business, and the mighty interests involved in the traffic of the city, they should indeed be glad to have the space now under considera-

tion, where they might call his attention to the artistic beauty of the south and east fronts of the Cathedral, as developed by the recent improvements effected by the Corporation. Regarded in this light and supported by the interesting historical recollections adverted to by Mr. Angell, the argument, he had no doubt, would be urged upon the Corporation with great force, and they would do well and wisely to yield to the common impression on the subject, that it would be unbecoming of the spirit of the age to let such an opportunity be lost, merely for the pounds, shillings and pence view of the question, and to sacrifice what he believed would be a more valuable monument to their taste and liberality than even the new and improved communication with which it was connected. He knew so much of the Corporation of London, and of their readiness to promote improvements, that he was always willing to be their defender; and he need only refer to the state of Copenhagen Fields in former days, as compared with the skilfully planned and well executed works now being carried out there, as an instance of their public spirit. The wit and eloquence of Mr. Angell's paper deserved the warmest acknowledgments of the meeting, and he begged to second the offer of their earnest thanks for the instruction which it had afforded them.

Mr. TWINING, Visitor, referred to a rule enforced by the municipal authorities of Paris, which provided, that when a house in any narrow thoroughfare was taken down, the new building should be set back 12 or 15 feet. By this means all the narrow streets were gradually widened; an object which could not be attained without the exercise of some authority. It occurred to him that of the Continental Squares, or open places, those which had no central monument or great architectural edifice, were generally architectural and symmetrical,—such as the Place de la Concorde, the Place Vendôme, and the Place du Carrousel. On the contrary, the open spaces surrounding the Cathedrals of Antwerp and Strasburg, and Notre Dame at Paris, presented no such regularity or symmetry. The Piazza of St. Mark at Venice, and the approach to St. Peter's at Rome were however exceptions, and undoubtedly the effect of St. Peter's was much increased by the beautiful access and the fountains in front of it. In the other cases it might be said that the effect of the cathedrals was heightened by their contrast with the small and irregular edifices around them. He was of opinion that space was the first requisite around a large and imposing edifice, and next to that, buildings somewhat in harmony with it.

Mr. F'ANSON, Fellow, trusted that the public might always be able to contemplate the beauty of St. Paul's, as now for the first time displayed. Mr. Tite had eulogized the Corporation, but he (Mr. F'ANSON) thought that on this occasion they might appeal not only to the Corporation, but also to the Government. In Paris, the municipality and the Government went hand in hand; and those who knew Paris thirty years ago and had seen it recently could testify with what success. The Rue de Rivoli was now perhaps the finest street in Europe. He believed that if the matter were properly submitted to the Government they would assist in promoting the object before the meeting, by giving to the Corporation of London the funds derived from the coal duties. The Government had already assisted in many civic improvements, and this assistance might easily be extended further. Victoria Street, Westminster, was promoted by a grant of £50,000 from Government, besides other advantages. It should be at once recognized that money expended in this way by the Government was indeed well spent; and it was most desirable that the inhabitants of the metropolis should have not one, but many architectural beauties to display to foreigners. London already possessed the finest bridges in the world, and a remarkably fine series of open squares, but it also displayed a great want of the appreciation of artistic decoration. The opening of the view of St. Paul's would refresh the eyes of passing thousands, and would tend to improve the public taste, and to promote decoration in minor objects.

Mr. PENROSE, V.P., regretted he had not been able to submit to the meeting some photographs which he had directed to be taken to illustrate the subject, which indeed had been so well urged by Mr. Angell and Mr. Tite, that it was almost impossible to add anything to their remarks. Looking to the wedge like form of the space of ground in question, and considering the very great portion of the Cathedral which must be hidden by building upon it, it was of the greatest consequence to "agitate" to get it left open, if possible. The greatest difficulty both to ourselves and to foreigners in contemplating the many really fine edifices in London, arose from the fact that the traffic of the whole city was so great that there was no favorable opportunity for looking at them. Hence the opening of a moderate space in such situations as this was most desirable, as it would afford an enjoyable position for seeing the buildings and shewing them to strangers, who, if they wished to sketch, need not then be exposed to an order to "move on."

Mr. BELLAMY, Fellow, could not refrain from expressing his sense of the importance of the opportunity now offered. Many non-professional men were not aware of the extreme beauty of the magnificent view which architects now sought to keep open. When he saw it on a recent occasion he was most forcibly struck with it, as the beau ideal of outline and composition. Instead of falling in with Mr. I'Anson's suggestion, he would say, let the honour be to the Corporation alone; and he was sure the city would not begrudge the sacrifice, great as it might be; the question should not be put upon the pecuniary consideration, but rather upon the honour which would accrue to the Corporation availing itself of the present opportunity. It was in contemplation, and he believed might be regarded as a *fait accompli*, that the statue of Peel should be placed at the north east angle of the Cathedral; now if a statue of Wren were erected at the south east angle, the balance of these statues would be a vast improvement to the city. He could not indeed conceive anything more calculated to elevate the minds of the people than the contemplation of the statues of so great an architect as Wren, and of so great a statesman as Peel. Every man who had read the life of Wren, must be moved by the greatness of his mind, his profound scientific attainments, and his high moral character; a lesson to all that those qualities might be combined. He therefore strongly urged upon all present the importance of the improvement in question, which they should strongly impress upon their friends, and which they might all aid in accomplishing.

Mr. RENNIE, C. E., having attended the meeting at the suggestion of his friend, Mr. Penrose, had listened with great interest to the admirable paper of Mr. Angell, and the remarks which had been made upon it. In the early part of his life he had been familiar with many open spaces which were now covered with buildings. He recollected Moor Fields with its long rows of trees, and ponds between them; Old Bethlehem Hospital with Colley Cibber's "brainless brothers,"—the remnants of Ranelagh Gardens,—and St. George's Fields, with that favorite resort, the Dog and Duck; but he remembered with still greater pleasure the locality of St. Paul's School, where he had passed some years of his education, and for which he had imbibed a love that had increased with age. In youth he had been led to consult the writings of Sir Christopher Wren, and had learnt to respect him as the founder of the Royal Society, as an astronomer, mechanician, and a mathematician; and especially in that capacity in which he was best known to the meeting,—a great architect. He, Mr. Rennie, was lately walking with his brother through New Cannon Street for the first time, and was so struck with the magnificence of the view of St. Paul's which it presented, that he at once expressed his anxiety that the triangular space at the east end of the Cathedral should not be again covered with buildings. His brother urged him to write to the "Times" upon the subject; but being unwilling to bring his name before the public, he wrote to Mr. Penrose; and that gentleman had thereupon written to the "Times" the excellent letter with which they were acquainted; he

was indeed gratified that public attention had been thus called to the subject. £60,000. was but a small consideration to the wealthy City of London. Such a sum was often thrown away by them on matters of mere personal gratification; and surely they should not neglect to expose to general admiration the finest work of the greatest architect of this country. This was an object worthy of the Corporation of the City of London,—they alone should take up the subject, and the honour of it should be theirs alone.

Mr. PIPER, visitor, expressed his admiration of the ability which the paper and the discussion had manifested. He ventured to say to the members of the Institute present, that from them the public ought to learn that their daily footfall was on ground of historical interest, and that they had amongst them monuments which such efforts as the present on the part of the Institute would shew them how best to see and enjoy. The Institute could have no more honorable task than to convince the public that they possessed in this metropolis architectural works of the highest value, and that it was their duty to preserve and appreciate them.

Mr. DONALDSON, Fellow, observed that there could be but one opinion amongst architects and men of taste upon the question. It had been said there were few points of architectural interest in the metropolis; but one had been forgotten, which he (Mr. Donaldson) regarded as amongst the finest which the world could present. Looking from the east end of the Poultry towards the Royal Exchange, with the Bank on the left, the Mansion House on the right, and the beautiful church in Lombard Street in view, an architectural group was displayed which he believed could not be surpassed in any other city. He trusted the Corporation would not lose the present opportunity, especially as that body included many men of taste; while apart from the question of architectural effect, he felt the great practical importance of this improvement in connection with its facilitating the access to the Railway Stations at London Bridge, now so much impeded by the crowded state of the streets. The advantage, in this point of view, of opening the space in question, would be at once seen by reference to the plan. With regard to the cost, it should be borne in mind, that if carried out, the improvement would always redound to the honour of the Corporation, whereas, if neglected, it would be a lasting reproach to them that they had the opportunity, and that for the paltry sum of £60,000. it had been thrown away. If once again built upon, the space could never be cleared again. It was comparatively a new feature in the thoroughfares of great cities that instead of being directed as formerly to the great entrances from the immediately surrounding country, they should be directed towards the principal railway termini. In Paris the Emperor had ordered the construction of a road 100 feet wide to the Strasbourg Railway Station, and so the Corporation should by every means promote the access to the Stations at London Bridge. In Glasgow and in Edinburgh the houses in the principal streets must all be faced with stone,—in New York a magnificent city was rising, with elevations of granite or of marble, and London should not be backward in the march of improvement. In the present question their opinions, as architects and men of sound practical sense, were unanimous, and he trusted the thoroughfare nobly commenced and carried on with so much credit by their friend Mr. Bunning, would be rendered complete by the preservation of the vacant space which had led to so much interesting discussion.

The CHAIRMAN conveyed to Mr. Angell the thanks of the meeting, and the proceedings closed.

ON THE DRAINAGE OF BUILDINGS AND STREETS IN THE METROPOLIS.

Being a Discussion (in continuation) held at the Ordinary General Meeting
of the Royal Institute of British Architects, May 15, 1854.

The Chairman, Mr. F. C. PENROSE, V.P. stated that it was necessary the discussion should be concluded that evening, and that in conformity with the wishes expressed at the last Meeting it should be confined as far as possible to the question of outfall, which had not yet been discussed. Although not immediately connected with their duties as architects, this branch of the subject was of very great importance, and there was ample room for a discussion of it with reference to scientific principles.

MR. FOWLER, Fellow, observed that the removal of sewage from the houses and conveying it under the streets had given rise to much interesting discussion at the former meetings, and although opinions might differ as to the best modes of doing so, there existed much greater activity and efficiency in house and street drainage than at any former period. But what was the result? The more that filth was drawn off from houses and streets, the more it was thrown into the Thames to pollute the stream and render it a source of annoyance and pestilence to the inhabitants along its banks. The offensive state of the river and its shores was a matter of notoriety. It had been urged that the body of water in the river was so large as compared with the sewage flowing into it, that the latter was so diluted as to be inoffensive, but the experience of their senses was sufficient to refute this assertion. In fact the offensive matter being lighter than the main body of the water floated upon the surface, and as it was not conducted into the main stream, it remained near the banks, where the velocity of the current was much less, and with the ebb of the tide it was deposited upon the shore. This matter, so offensive to the senses and so injurious to the health, was in itself valuable, and if it could be applied to the land as a fertilizing agent, its value would be incalculable. Various schemes had been proposed for accomplishing this object, especially one which in a commercial sense had been a failure, although it had so far succeeded as to shew that the sewage water might be dealt with in the above manner if the proper means were applied, and if the matter were taken up as a public measure rather than as a private speculation. Other modes had been suggested, and sewage manure had been manufactured in a solid form, but these had all been failures. At the present time Mr. Wicksteed, the Engineer of the East London Water Works, was engaged in a very large speculation of this kind at Leicester, by which he hoped to obtain the offensive but valuable matter from the sewage when collected in reservoirs, and to leave the water pure. He, Mr. Fowler, looked with much anxiety and interest to the result of this experiment, especially with reference to the possibility of its application to the metropolis, but he had some misgivings as to its success. Another plan which had been proposed was that of conveying the sewer water direct by main pipes into the country, and then distributing it over the land; and in many instances liquid manure had been so applied with most beneficial and profitable results. With respect to the views of the Government, to whom the decision of the question must eventually come, Lord Palmerston had declared that they would consider no general plan for the drainage of London effective which did not provide for saving the river from pollution, and at the same time preserving the products of the sewage for fertilizing the country. If this were the right principle, it was obvious that the sewage should be carried by the shortest and most easy courses into the country direct, and therefore the majority of the plans proposed, suggesting as they did the concentration of the sewage at a spot some distance down the river, had a tendency to obstruct that principle, and were therefore inadvisable. These plans too still made the Thames the receptacle of the sewage, and he (Mr. Fowler) believed that even from below Greenwich

it would be carried upwards by the flow of the tide as far as Hammersmith. It would in fact be kept floating up and down with each tide, and would only get half a mile lower down at each ebb. Thus both of the principles laid down by Lord Palmerston would be violated. The subject was one of great importance, and it had not escaped the attention of the Government. He had great apprehensions that the plans hitherto proposed, although emanating from gentlemen of great talent and authority, would hardly fulfil the objects intended, and he was therefore anxious that the subject should be fully discussed, in order that some plan likely to ensure satisfactory results should be adopted.

MR. MOREWOOD, representing the Great London Drainage Company, stated that the question before the Meeting was the "outfall" for the drainage of the Metropolis, and as the Board of Health plan dispensed with all the present arrangements, and consequently with the necessity for an outfall, it might be well to say a word in reference to their plan, as recommended by Mr. Fitzroy to the Metropolitan Commission of Sewers, which had been ascertained to be identically the same as that which the Sanitary Commission advocated in 1848. It consisted of "liquid distribution of sewer water," of "pipe sewers" and "pipe drains." Liquid distribution had now been advocated for ten years, and was specially in favour in Greek Street in 1849, and yet up to this time there was not one instance of its being used in any one of the towns under the Board of Health. In fact he declared it to be entirely fallacious, and that it never could be carried out profitably. As to pipe sewers; Sir Christopher Wren built a sewer 20 inches by 14 from Cripplegate to Bridgewater Square in 1691, and in 1714 it had to be taken up and rebuilt 4 feet by 2 feet. Mr. Kelsey, the late very able surveyor to the City Commission of Sewers stated, "it is not in the least improbable that, if drains and sewers are so wire drawn as barely, and that with the most unremitting attention to their cleanliness, to suffice for the ordinary discharge of the foul waters of houses, and of ordinary showers of rain, another generation will not pass away before another re-modelling of such matters will be found imperatively demanded, as one may with tolerable certainty predict that if sewers should be built into which a man cannot get to examine and repair as time shall gnaw them away, the evil day must and will come when the whole will have to be re-constructed." In reference to reducing the optional sizes of house drains to 12 by 9 inches, he said, "with what advantage or detriment time will shew," and the very words which he used in respect to stoppages and failures, were the same as those used in a report from the Board of Health in reference to Croydon. "In cleaning the obstructed sewers, however, it has generally been found that the stoppages, whether in 4 or 6 inch pipes, have occurred from substances which ought never to have gained admittance to the sewers at all. From Mr. Simpson's evidence in 1846 it appeared that the Chelsea Water Works Company had laid down a quantity of earthenware pipes, which after a few years had a dull sound when struck, and when they burst might be crumbled with the hand. At Croydon some of the pipes were found to have become softened, and there was moreover the Metropolitan Commissioners' report of failures, with a vast number of illustrations. The Board of Health plan of liquid distribution of sewer-water of pipe sewers and drains was therefore entirely inadmissible.

The recognition of that which the Metropolis requires, a lower outfall than the Thames, was to be found in a pamphlet in 1839, emanating from an architect, who, after shewing the existing levels in Westminster, states that it is quite impossible for the Commissioners of Sewers to remedy the evils complained of. They had for years past endeavoured to palliate the mischief; all the sewers in Westminster for twelve hours out of the twenty-four were merely cesspools or reservoirs, the mouths being closed by sluice gates; indeed, were it not for these gates every house in Westminster, even those in Park Street and James Street, would at high tides be inundated with the filthiest of floods. In 1846 Mr. Donaldson gave very decided evidence in reference to the inefficiency of the present outfall

into the Thames, and showed how readily the Westminster Commissioners of Sewers were availing themselves of the temporary lower outfall caused by the removal of old London Bridge ; and in 1847 Mr. Wm. Hosking in a postscript to his work, strongly warned the Government against further clogging the sewers and the Thames, " unless the refuse can be certainly hurried on through the sewers, and in a diluted state to an *effective outfall*." Mr. Simpson, when asked in 1851, " If water be not drawn for domestic purposes below Hammersmith Bridge, do you see any objection to the Thames continuing the means of drainage to the Metropolis," replied, " Yes, I do. I think it would be the greatest gift to the Metropolis if we could convey the sewage lower down." This lower " outfall," this removal of the sewage Mr. Morewood considered could alone be effected by the drainage plan with which he was connected, commonly known by the name of the Great London Drainage, which consisted of two tunnel sewers extending on each side of the Thames respectively, from Chelsea and Vauxhall to the marshes east of London, the sewers running under the streets and roads, as the Strand, Fleet Street, &c., to be made by tunnelling, and to be laid with an artificial or additional fall, so that the sewage might be passed away from the Metropolis and pumped up at the terminal works, there to be formed into a dry manure, the refuse water being thrown on the top of the tide. He stated that this drainage plan had been prosecuted in the session of 1848, when it had been very favourably entertained by the Government, but it was most unexpectedly stopped at the second reading on the 7th March, 1848. In 1853, the proposed works and estimates had been proved before a Select Committee of the House of Commons, and the minutes of evidence printed by the House, with a view to future legislation, and the chairman of the Committee had stated to the House, that *they had fully approved* of the works proposed, viz. two tunnel sewers to deliver the refuse below the town. In reference to the Metropolitan Commission of Sewers, Mr. Morewood stated that their own report to Parliament in 1851, fully identified them with these very works ; the tunnel sewer on the north side being described as from Chelsea " to the pumping station on the river Lea," and that on the south side as " a system of sewers between a point near the top of Woolwich Reach and Vauxhall, the main line and branches comprising upwards of thirteen miles." A report from the surveyors of the Metropolitan and City Commission of Sewers entirely approved of the line of those sewers as proposed by the Great London Drainage Company, declaring in reference to the north side that it was in some respects better than the alteration adopted by the Metropolitan Commission (in 1851); and respecting the south side, " the general levels of the district, as well as the levels of the invert of its sewers are such that the interception of the sewage can be effected by either scheme." Respecting high level sewers, by which the question has since been complicated, they expressly said, " and it would in our opinion be found necessary at some future day to construct upper lines of intercepting sewers.

The point of difference with the Commissioners was the guarantee of a contingent interest of three per cent. for twenty-five years ; and also the Commissioners not having taken into their calculation that the tunnel sewers were never intended for Richmond and Croydon ; that evaporation amounted to thirty-two inches when the rainfall was twenty-seven inches ; that absorption materially reduce the quantity of rain water to be provided for by tunnel sewers ; and that immense storage room was already in existence for storm waters, which would pass through the present channels into the Thames, when the quantity of ordinary sewage, ten or twelve million cubic feet, exceeded the thirty-seven millions for which the two tunnel sewers provided.

MR. G. R. BURNELL, C.E., in reference to the deodorizing of sewage water, alluded to the works which had been carried on at Cardiff, and said that Professor Way had informed him that there was a great difference between the sewage water of large and of small towns, and that the sewage of London when it had passed through great length of sewer, and arrived near the outfall, had lost so

much by evaporation that it contained very little indeed of really valuable matter available for agricultural purposes. Seven years ago he had visited the works near Chelsea referred to by Mr. Fowler, and although they had been highly eulogized at the time, he found that they did not distribute sewage water at all, but merely the water from a canal.

MR. FOWLER explained that that had been the case only in the commencement of their operations, the main was afterwards laid into the well.

MR. BURNELL said the fact was as he had stated it even more recently.

MR. FOWLER said that Mr. Burnell had been misinformed. In 1852 the company distributed a great quantity of sewage water.

MR. BURNELL considered the general question to be purely of an engineering nature, and that the Home Secretary was travelling out of his path in deciding that an uniform system should prevail, when in fact nothing was clearly known upon the subject, and scientific men declared that the sewage of small towns was fit to be profitably used, whilst that of large towns was not.

MR. FOWLER believed that the Government merely asserted a general principle which did not involve any engineering question. It was simply a question of economy, and one that might be properly taken up by the Government. They had not gone so far as to dictate any particular mode of carrying out their principle. Mr. Fowler added that the discharge from the King's Scholars' Pond sewer had been found to possess fertilizing qualities in a very high degree.

MR. HAYWOOD, C. E. observed that the question of outfall hinged entirely upon the question of the value of the sewer water. If it could be proved that manipulating the latter would pay five or six per cent. small manufactories might be established at the mouth of every sewer, but unless it could be made to pay it would not be so dealt with. If the drainage was not to flow into the Thames intercepting sewers were necessary; and if though flowing into the Thames its reflux was to be prevented, then it should of course be carried sufficiently low down to prevent its returning with the tide. With regard to irrigation with sewer water he had no doubt of its advantages, but he much questioned whether it could be made to pay. The mode of draining towns should be regulated by natural and local features. In country towns it was natural to attempt the distribution of the sewage in a liquid form, and where a town was drained into a beautiful trout stream, it should be a *sine quâ non* that something should be done to get rid of the sewage before it polluted the water, whether the means adopted paid or not. The magnitude of the drainage of London (amounting as it did, without a drop of rain, to twelve millions of cubic feet of water every twenty-four hours) was a serious obstacle to any purifying scheme, but even that would be surmounted if it would pay five per cent. The late John Martin was the first to originate the idea of intercepting sewers; he was followed by Mr. Foster, Sir Wm. Cubitt and many others, and lastly by Mr. Bazalgette and himself. Their plan had no particular novelty, but they believed it was the best that had been laid down; they considered that the great fault in the plan of the Great London Drainage Company was that it was not sufficiently comprehensive, and did not allow for the extraordinary influx of storm waters. A scheme of this kind should be available for the next thirty years at least, and not be liable to require reconstruction in every ten years; they also objected to the pumping on Mr. Morewood's plan, preferring drainage by the natural force of gravitation as a cheaper system, and one not so liable to accidental interruption. Mr. Fowler was in error as to the effect of the tide upon the sewage, if admitted into the Thames some distance below London. The plan of Mr. Bazalgette and himself was that the sewage should be discharged, say at Woolwich, only with the first two or three hours of the ebb tide, and in that case none of it would return so high as the point at which it was discharged. He did not believe that the Thames was polluted to the extent that was generally supposed, but as the population was so rapidly

increasing, and would probably amount to five millions in thirty years, the river would certainly not be improved in that time. The sewage was an infinitesimal quantity compared with the water of the river, and was far less injurious than the public imagined; four minutes of ebb tide at London Bridge would suffice to carry down all the real fecal matter of the twenty-four hours, if collected together, and much of the effluvium which arose at low water was in consequence of the sewers discharging their contents upon the shore, instead of being conveyed by culverts to parts below low water mark. Mr. Haywood repeated that the whole subject turned upon the value of the animal matter contained in the sewage, and he should consider £50,000 well spent in determining the value of this matter when relieved of seven hundred times its bulk of water. All the illustrations of its value had been drawn from places where its dilution was not one-third or one-sixth so much as in London. Thus at Edinburgh the valuable matter was so highly concentrated that its distribution over the surrounding meadows had become a fearful nuisance, but it had been argued that in London all the smell would be lost in two minutes and a half.

Mr. AUSTIN, Visitor, produced a drawing of his proposed plan of Sewerage, which consisted of a large tunnel below the streets, providing at the same time space for gas and water pipes, and containing a tramway for connecting the different railway stations. He also produced a plan of drainage by means of two tunnels under the bed of the river on each side. He proposed that only the flood or rain water should pass directly into the Thames. Mr. AUSTIN alluded to a plan of deodorizing sewage water, and rendering it so pure that it might be drunk. He urged that the fertilizing properties of sewage manure had been clearly proved at Glasgow. In reply to the CHAIRMAN, he stated that he had not made any estimate of the cost of his project, and that the size of his tunnel was 26 feet in height by 18 feet in width. He did not consider this too much, looking to the increase of population; on the contrary, he considered all the existing sewers were much too small. The value of the sewage running to waste in the river was incredible, but some idea of it might be formed when he stated that six crops of rye had been obtained in one year by using sewage water. Hence he felt assured that sewage matter, properly collected, would pay a proper return on the outlay.

Mr. GARLING, Fellow, said it was a question whether deodorizing sewage did not spoil its agricultural purposes; and, moreover, he believed that although mechanical purity could be obtained, chemical purity could not, and that however pure, apparently, such water would be unfit for ordinary purposes. The organization of a general system of sewerage was properly the duty of the Government: but if it could be made to pay, which he very much doubted, he believed it would be better carried out by private enterprise. The question of the proper course for the outfall must depend on a system of levels very accurately laid down. In reference to Mr. Haywood's statement, that Mr. John Martin was the first to originate the idea of intercepting sewers, Mr. GARLING read an extract from a letter written by himself in 1824, referring to a project which he had put forth ten years before. This shewed that he (Mr. GARLING) had really proposed intercepting sewers before Mr. Martin did so, and that his views at that early period were similar to those of Messrs. Bazalgette and Haywood.

Mr. MOREWOOD observed that a very similar plan had been suggested by Mr. Dodd fifty years ago. He stated that the Great London Drainage Company contemplated the formation of high-level sewers in addition to low-level sewers, as the size and population of London increased, and that their plan was fully adequate to provide for the ordinary rainfall in the metropolis.

Mr. BOULNOIS, Associate, begged to make a few observations by way of general reply, not limiting his remarks to outfall only. He had stated in the paper which had led to this discussion, that all the plans proposed were so expensive in their nature as to preclude the possibility of their being carried

out. Of all the plans that of Mr. McLean was, perhaps, the most feasible. It appeared that all parties were agreed that the outfall should be at some point low down the river, that the expense should be modified as much as possible, and that the details must be left to those engineers who were capable of carrying them out. On the question which had been first raised, namely, the merits of pipe sewers and brick sewers, it was remarkable that, with the exception of a pipe manufacturer, not a single advocate for pipe sewers had come forward. Some gentlemen had said that they adopted them for cheapness only; but not one had said that a pipe was better than a brick sewer. As the advocates for brick sewers had thus thrown down the gauntlet, which had not been accepted, it must be taken that they were all agreed that when the cost was the same the brick sewers were to be preferred.

Mr. RAWLINSON, C.E., expressed his dissent. He had been absent from London at the time of the former discussion, but if another evening could be devoted to the subject, he pledged himself to meet the objections to pipe sewers.

The CHAIRMAN suggested that Mr. Rawlinson should at once dispose of the subject.

Mr. RAWLINSON proceeded to say that in reference to outfall, it was a question for practical engineers. He begged to caution the public against tunnel sewers for conveying sewage at a great depth, perhaps twenty or thirty yards below the surface, and then pumping it up again, a plan which he considered most objectionable. Its cost, moreover, could not be estimated; and it might be ten, fifteen, or twenty millions. The Victoria Sewer was estimated to cost £15,000., but he believed it had cost double or treble that sum. With regard to pipes, he could not fully enter upon that point; but would say that he had sewered entire towns on the pipe system, which had since been in use twelve or eighteen months, and he would stake his professional character upon those works. Four years ago he was sent for by Lord Grey to remedy the defects of a brick sewer, 5 feet high and 3 feet wide, which ramified under his house in Northumberland. He substituted for this earthenware pipes 6 inches in diameter (with asphalted canvass wrapped round the joints), and those pipes had effectually carried off the soil refuse, roof refuse, yard refuse, &c., ever since, without the slightest annoyance, stoppage, or breakage. He was now, in conjunction with the Duke of Northumberland's architect, revising the drainage of Alnwick, which town, as well as Morpeth, was entirely drained by pipes.

Mr. BOULNOIS must state that it was against pipe *sewers* in streets, not against pipe *drains* in houses, that he had mainly directed his observations. He did not consider Morpeth and Alnwick, where one house in six or eight drained into a small pipe *sewer*, at all satisfactory as evidence in favour of the pipe system. It was clear, from the former discussion, that in the metropolis pipe *sewers* had failed. Mr. Bazalgette and Mr. Haywood admitted this, and the latter gentleman had given an instance of failure in Leadenhall Market which he was unable to account for. The advocates of pipes had had seven weeks for consideration, and he looked upon it as nothing more than a *ruse de guerre* for them to come forward at the last moment, and to say that if they had the opportunity they could say a great deal in favour of the system.

The CHAIRMAN was sure that, on consideration, Mr. Boulnois would qualify this remark. They had now reached the usual hour for adjournment, and the discussion, which had extended beyond the usual length, must be brought to a close. Much interesting information had been elicited, and it only remained for the Members to return a vote of thanks to the many gentlemen by whom it had been so kindly afforded.

The vote of thanks was carried unanimously, and the meeting adjourned.

Correction in the discussion of April 3rd, 1854.

Page 106. The last sentence should read thus:—The original supply of water from Coombe is conducted through a main pipe under the River Thames, and the other source of supply is known as the Longford River; both these services are maintained to the present day in perfect order.

ON SOME RECENT DISCOVERIES AT FOUNTAINS ABBEY.

Extracts from Letters forwarded by the Earl de Grey, President, read at the Ordinary General Meeting of the Royal Institute of British Architects, May 29th, 1854.

Ripon, January 1854.

MY LORD,

I have to apologize for not writing earlier respecting the interesting excavations now in progress at your Abbey of Fountains, but I have been waiting until the works had progressed as far as the middle transept; because, according to the MS. Chronicle deposited among your Lordship's archives, it appears that most of the Abbots, *after* the year 1435, were buried in the transept, or at the east end of the nave. However, as yet the excavators have only uncovered two tombstones, one of which (that of Abbot Ripon, 1435) we had seen in the partial openings that took place in 1841.

To give the clearest idea that I can, I will detail in order the result of the discoveries in this present excavation, commencing with the west gateway, through which the railway had to be cut, in aiming for the great west door of the Abbey church.

First, on the south side of the gateway a large room (No. 1 on the plan) not yet of course thoroughly cleared, with strong marks of fire on the floor, and an immense quantity of ashes, as if the place had been burnt down; an "Early English" bracket of one of the groining ribs is one of the most beautifully simple and elegant I have ever seen.

Two or three different levels exist in the space between the gateway and the west door of the church; this is called in some of the records *the first Court*; it appears to have been paved with cobbles.

No. 2 on the plan marks the site of the porch (15 feet wide from west to east) hitherto totally unsuspected; it is of later date than the nave, being apparently "Early English," of a period just subsequent to the date of the Lady Chapel (A.D. 1245);* the date of the nave, with its massive pillars, is between 1140 and 1156; the fragments of the porch denote it to have been of a very novel design, but of course the space it covers cannot be thoroughly cleared until the excavations in the church are finished.

No. 3 marks a tombstone without the slightest trace of brass or inscription; it is a fine large stone nine feet long, with a border of plain Tudor tiles round it; the position is peculiar—the head of the stone being close to the *west* wall of the north transept; whereas the general feeling and custom were to have the foot of the grave as near as possible to the east portion of the part of the building in which a person was buried. May this stone have covered Abbot Thirsk—one of the rebels in the insurrection of the "Pilgrimage of Grace," who suffered at Tyburn, but whose body was brought back to Fountains for interment? Or is it the grave of the great architect of the tower—Huby?

* Since this porch or "Gallilee" has been thoroughly cleared, I find that I am only *partly* right in referring its date to a period subsequent to 1245. The base of the doorway, and the fragments of dog-toothed early English caps and arches only show that extensive insertions and alterations have taken place subsequent to 1245. *The original structure was Norman, of a date very little later than that of the nave itself.*—say circa A.D. 1170, or 1180.

who might consider that the buildings he had caused to be reared were quite sufficient to perpetuate *his* name, without a tomb richly inlaid with brass, or gorgeously carved.

No. 4 marks the large *blue marble* slab which covered Abbot Ripon (1435); it has been richly inlaid with a brass figure of the abbot, two shields of arms, a mitre, a canopy, and a very long inscription surrounding the whole. It was much broken, but it has been admirably set straight and repaired under the instructions of Mr. Mason.

No. 5 marks the site of the "Early English" base of a Holy Water Stoup, near the entrance from the Cloister Court.

No. 6 (in the Chapel of St. Michael the Archangel) is the most perfect relic yet found of the coloured pavement laid down by Abbot John de Cancia (1220-1246-47); it is a copy of a pattern at Sawley Abbey, though differently arranged. All the pillars of the choir have been pulled down to their foundations, except those numbered 7, 8 and 9 on the enclosed plan. Fifteen feet east of Abbot Ripon's tomb is the platform of the choir with an ascent of two steps.

Nos. 10, 11, 12, 13, 14 and 15 on the plan mark the bases of six of the nine altars of the [so called] Lady Chapel, the other three being under the east window. I would respectfully suggest the propriety of re-opening the aumbries (or plate closets) of these altars, which appear to have been walled up in Mr. Aislaby's time. One of the piscinas of these chapels, discovered close to the remains of its altar, shows that the majority of them were of the same character as those at Jervaulx, and *fixed in the floor*. The first chapel at the south end had once a fine large piscina *fixed in the wall*.

A fragment of a gravestone turned up in the rubbish of the south transept is inscribed, "Orate pro a't'a;" I hope more of this stone may be found; it is of limestone—date late in the fifteenth or early in the sixteenth century.

Abbots Darnton and Huby (1479-1526) appear to have repaved portions of the transept and nave with tiles of the same pattern as those found in the Hall of the Abbot's house: one has the arms of the Abbey—three horse shoes—surrounded by that beautiful and appropriate inscription, "*Benedicite fontes domino*;" the other has a Mitre and a Crosier on a shield, impaling Huby's initials M. H., and his favourite inscription, so frequently repeated on the tower, "*Soli deo honor et gloria*."

As many of these tiles have been severely burnt, apparently by large fires kindled on the floor of the nave and transept, and as the earth in several places is quite black with ashes, I have no doubt but that when the abbey was pillaged, great bonfires were made of the wooden lattice work and screens, and the lead of the roofs was melted into "pigs" for more convenient carriage. A passage in a curious letter published by Sir Henry Ellis is highly illustrative of this idea, and gives a complete picture of the destruction that took place at the dissolution of the Monasteries.

The writer, who lived in Yorkshire, says, "it would have made a heart of flint to have melted and wept to have seen the breaking-up of the house, and their sorrowful departing; and *the sudden spoil that fell the same day of their departure from the house*. And every person had every thing good-cheap, except the poor monks, friars, and nuns, that had no money to bestow of anything, as it appeared by the suppression of an abbey, hard by me, called the Roche Abbey; a house of white monks, a very fair-built house, all of freestone, and every house vaulted with freestone, and covered with lead (as the abbey was in England, as well as the churches be). At the breaking-up whereof an uncle of mine was present, being well acquainted with certain of the monks there; and when they were put forth of the house, one of the monks, his friend, told him that every one of the convent had given to him his cell wherein he lied; wherein was not anything of price, but his bed and apparel, which was but simple and of small price; which monk willed my uncle to buy something of him, who

said, 'I see nothing that is worth money to my use.' 'No!' said he, 'give me ij^d for my cell door which was never made with v^s.' 'No,' said my uncle, 'I know not what to do with it' (for he was a young man unmarried, and then neither stood in need of houses nor doors). But such persons as afterwards bought their corn and hay, or such like, found all the doors either open, or the locks and shackles plucked away,* or the door itself taken away, went in and took what they found, and filched it away.

"Some took the service[®] books that lied in the church, and laid them upon their waine-coppes to piece the same; some took windows of the hayleith and hid them in their hay; and likewise they did of many other things; for some pulled forth the iron hooks out of the walls that bought none, when the yeomen and gentlemen of the country had bought the timber of the church. For the church was the first thing that was put to the spoil; and then the abbot's lodging, dorter and frater, with the cloister, and all the buildings thereabout within the abbey walls; for nothing was spared but the ox-houses and swine-cotes, and such other houses of office that stood without the walls, which had more favour showed than the very church itself; which was done by the advice of Cromwell, as Fox reporteth in his book of Acts and Monuments. It would have pitied any heart to see what tearing up of the lead there was, and plucking up of boards, and throwing down of the spars; and when the lead was torn off and cast down into the church, and the tombs in the church all broken (for in most abbeyes were divers noble men and women, yea, in some abbeyes, kings, whose tombs were regarded no more than the tombs of all other inferior persons; for to what end should they stand, when the church over them was not spared for their cause?) and all things of price either spoiled, carped away, or defaced to the uttermost.

"The persons that cast the lead into foddors plucked up all the seats in the choir, wherein the monks sat when they said service, which were like to the seats in minsters, and burned them, and melted the lead therewithall, although there was wood plenty within a flight-shot of them, for the Abbey stood among the woods and the rocks of stone, in which rocks was pewter vessels found that was conveyed away and there hid; so that *every person bent himself to filch and spoil what he could, yea, even such persons were content to spoil them that seemed not two days before to allow their religion,* and do great worship and reverence at their mattins, masses, and other service, and all other their doings, which is a strange thing to say, that they could this day think it to be the house of God, and the next day the house of the devil; or else they would not have been so ready to have spoiled it.

"For the better proof of this my saying, I demanded of my father, thirty years after the Suppression, which had bought part of the timber of the Church, and all the timber in the steeple, with the bell frame, with others his partners therein (in the which steeple hung viij. yea ix. bells; whereof the least but one could not be bought at this day for xx^{li} which bells I did see hang there myself more than a year after the Suppression), whether he thought well of the religious persons and of the religion then used? And he told me yea; for, said he, I did see no cause to the contrary. Well, said I, then how came it to pass you was so ready to destroy and spoil the thing that you thought well of? What should I do? said he. Might I not, as well as others, have some profit of the spoil of the Abbey? for I did see all would away, and therefore I did as others did. And thus much upon my own knowledge touching the fall of the said Roche Abbey."—*MS. Cole, vol. xii. Ellis, III. iii. 35.*

* It may not be uninteresting to state that the late Ralph Tinsley, of Fountains—for many years the burly blacksmith at Studley Hall—purchased of his predecessor, or his executors, a great quantity of old iron—door hinges, staples, and crooks—which the said predecessor had wrenched from the Abbey walls. Ralph used to declare that it was the toughest iron *he* ever worked up.

Ripon, February 16th, 1854.

Shortly after writing the letter in January a few curious discoveries caused me to delay sending it, in order that I might forward additional information.

The rest of the gravestone beginning "*Ora pro a'ta*" has been discovered in the south transept (No. 16 on the plan). The inscription, in fine black letter, shows it to have covered the remains of Brother John Rypon "*Fr's Joh's Rypon*," a monk I suspect, and not the abbot of that name. Unfortunately the portion of the stone that would have furnished us with the title and dignity of "Brother John" is broken. The date, too, is gone, except the name of the month (March), and the last figure of the year of our Lord . . . 4.

I have since discovered, after a minute examination of the base of the Holy-water stoup, (No. 5 on the plan) that its marble basin is *now used as the Baptismal Font in Aldfield Chapel*. It is most beautifully carved, and is evidently the work of the marble-mason of the Abbey during the erection of the choir and Lady Chapel (1204, 1245), who is styled in the charters of *that date*, "Thomas, Marmorarius de Sawley."

A screen once crossed the nave from pillar to pillar (No. 17 on the plan). In a space in the thickness of this screen a very curious discovery has been made, viz.—A number of large earthenware jars laid on their sides, and embedded in the base of the wall, a very few inches below the level of the floor. They were filled with charcoal ashes, but at present it has puzzled us all to discover their use. I hope shortly to be able to send a drawing of the place, and a correct sketch of one or more of the jars.

At the west-end of the nave, and a few feet in front of the pillars, we have found one or two of the *processional* stones.* They are of Morkar limestone, about 2 ft. 3 in. square, with a ring lined out in the centre. On these stones the Abbot and brethren arranged themselves prior to proceeding to perform service in the Choir. The stone on which the Abbot stood was *in the middle, at the west end*, only a few feet from the *west door*. Similar stones were formerly visible at the west-end of the nave of York Cathedral.

Bases of stone altars have been discovered fixed to the pillars of the nave. Two pillars have brackets for the images of the Saints to whom these altars were dedicated. One altar (no doubt a wooden one) was placed on a small platform of tiles a foot higher than the floor of the rest of the Church.

But the most curious discovery of all is the existence of a "Galilee" or west porch (No. 2 on the plan). To our astonishment we found that this porch had occupied the whole breadth of the west front (70 ft.). I suspect from the remains of the architectural fragments that it had a series of interlacing arches, with double shafts, and that this arcade was always open to the air. The wall would be about 4 ft. high to the bases of the columns supporting the arches and its superincumbent structure. At the south-end of this porch are five coffin slabs—the cross-heads on three are missing, the other two are plain, excepting their slightly moulded edges. At the north-end are two coffin-slabs—the first is plain, the other, close to the north wall, is the most perfect yet discovered. The device it bears is a processional cross of the *patée* form, enclosed in a circle. It is in its original position on the stone coffin, and firmly fixed with metal cramps.

* A minute investigation has since shewn that the processional stones at Fountains are *fifty-two* in number. They range in two straight lines seven feet distant from the bases of the nave pillars—the pathway between them being 12 ft. 8 in. wide. The cross-bearer's stone is in the middle, at the east end of the range, *ninety* feet distant from the Abbot's standing place.

In this porch, nearly in front of the great west door, was found the prostrate and mutilated figure of

“The Virgin Mother of the God-born Child.”

The Abbey was dedicated to the Virgin Mary. It is but the remains of a fine statue—the head gone, and the figure of our Saviour nearly all broken off. I have no doubt it occupied the now vacant niche above the great west window. This window was *inserted* by Abbot Darnton between March and May, 1494, and the figure of the Virgin is of the same date.

It is useless to expatiate on the wonderful effect this last excavation has given to the appearance of the interior. It is quite marvellous. In fact the Abbey is now another place altogether. The opening of the great staircase, from the nave to the monk's dormitory, has given a fine effect to that portion of the church to which it is attached.

In clearing out the undercroft of the vestry (No. 18) the bones of more than 400 skeletons have been found piled in a somewhat regular order. This place was always called the “*Bonehouse*” by the old guides, but I feel certain the deposit is subsequent to the dissolution of the Abbey (A.D. 1539).

An opportunity could now be taken to get casts of two small, but beautiful statues in the tower, as well as the Angel on the fine canopy, holding a shield with Abbot Huby's initials. This last carving is important, as it fixes the date of the tower, and I am afraid that both it and the figures (being cut in limestone) are beginning to suffer from the effects of the weather. I would suggest that all these casts, after the sketches are taken, should be deposited in the Museum, which I understand is to be formed in the “*Hall of Pleas*”—the dry groined room over the kitchen.

Ripon, 17th March, 1854.

MY LORD,

Capt. Smith has favoured me with a perusal of your note respecting the singular rude vases or pots found at Fountains. The drawing (by Mr. H. W. Todd), the plan and the section herewith forwarded, will, I trust, be found sufficiently explanatory of the position and appearance of these very curious objects.

The wall in which the pots are deposited is, evidently, the base of a passage in the thickness of the old screen, which might be entered by a doorway in the side wall of the entrance through the screen; the floor being a step or two below the general level of the Church. There is a small room in the thickness of the choir screen at Ripon Minster, on the north side—the similar space on the south side being occupied by the stone staircase leading to the organ loft. The screen in the Church at Fountains, not only crossed the nave from pillar to pillar, but it also occupied the space of the last arch of each *side aisle* of the nave. The pots or vases are laid in the wall on their sides, embedded in mortar. The depth of each vase is from 12 to 14 inches; the diameter across the widest part, 10 inches; the mouth 6 or 7 inches diameter. The necks of those in the west wall protruded slightly from the masonry; those in the north wall, when perfect, projected a little further.

The presence of the charcoal in and around the vases will not, I fear, assist us in coming to any conclusion as to the real use of them. For the charcoal found here filled nearly the whole of the space No. 1 on the plan, and may have been the embers of the fires (fed by the stalls and other lattice work) when the lead was melted at the dissolution of the monastery. Charcoal was also observed on several parts of the floor of the nave. Cinders were also found *in very small quantities*, mixed with charcoal in large quantities, in the pots

or near them. It may be well to remark that the whole of the depressed space in front of the wall in which the pots are embedded, was filled with charcoal. It is my opinion that the charcoal has nothing to do with the purpose or use to which the pots have been put. We know, from written record, that the lead from the roof at Fountains was melted into "*pigs*," and the remains of a small furnace, (*evidently post-reformation work*) were found, in making the recent excavations, attached to one of the pillars of the nave, *near* to the place where the pots were discovered. In fact, charcoal was found strewed in large and small quantities over the floor of the nave and transepts.

The "*written record*" alluded to, is in the muniment room at Studley Royal; and it discloses the fact that a man was prosecuted for stealing "*pigs*" of lead from the Abbey at Fountains, in the time of Sir Richard Gresham, who had the site granted to him shortly after the dissolution.

I think these pots have been placed for some *local use*, which it is now impossible to guess. Their position proves that they could not be of much use for holding oil, or any liquid. They must have been intended to receive some *dry* substance, that could easily be taken out by the hand. One visitor, the other day, asserted that there was a similar instance in Durham Cathedral. But I cannot hear that such is actually the case. Mr. Walbran has written to the Rev. Jas. Raine (the Librarian of the Cathedral) on the subject, but a reply has not yet come to hand. Mr. Raine's able and learned little book on Durham Cathedral says nothing on the subject.*

Your Lordship remarks that this screen across the nave would have thrown the whole of the transept, north and south, into the choir. This arrangement was not uncommon, particularly in the Norman period; but the choir would only *cross* the transept, and the north and south ends would be screened from the middle space, the breadth of the nave, or perhaps the breadth of the nave and aisles: the choir of Westminster Abbey is continued into the nave, *as far as the fifth pillar from the east*.

Before the erection of the beautiful choir and Lady Chapel at Fountains, we know from the Abbey Chronicle (written by Hugh, a monk of Kirkstall, between 1225 and 1247) that the Norman choir was a contracted space, and too small for the "*unusual*" number of monks officiating at that period. This caused John de Ebor, the Eighth Abbot, in 1203, to project the erection of the new choir. The plan† of Kirkstall Abbey Church—a daughter of Fountains, and built under the superintendence of the brethren of the latter house, gives the best idea of what the plan of Fountains was, previous to the days of John de Ebor. The Church at Kirkstall has never been altered in *plan* from its Norman form. Insertions of perpendicular windows, and the addition of a story in the same period (temp. Henry VII), to the centre tower, have taken place; but in plan the Church is just as it was first built, and I have no hesitation in saying that it was copied from Fountains.

If we dig a slight trench down the *centre* of either the north or south aisles of the choir at Fountains, from east to west (where the pavement is all gone, and where we can do no harm), we shall very probably discover the site of the eastern wall of the old choir, for I know that in several instances, where similar elongations have occurred, the old walls were only pulled down to the exact level of the floor.‡

* Mr. Raine has communicated with Mr. Walbran on the subject. He says there is nothing of the kind in Durham Cathedral. All traces of ancient arrangement *on the floor* have been obliterated.

† See Sharpe's Architectural Parallels; Ground Plans, Vol. 1.

‡ His Lordship having expressed a wish that the termination of the Norman choir should be sought for, on Monday last (5th June, 1854), after half an hour's excavation, it was found together with the eastern walls of the first north and south chapels. It differs slightly from that at Kirkstall, inasmuch as these *first* chapels, on either side, are longer than the others. Its extent and position is indicated on the plan. Mr. Walbran discovered the Norman choir at Sawley shortly after the completion of the excavations there.

I think, too, that the choir at Fountains may once have been continued further down the nave than the screen on the east side of which the pots have been found. There are clear indications of another screen—a wooden one; on the 6th or 7th pillars of the nave, from the west. But the whole of the church has been screened and divided into chapels with altars, in every direction. The space for 94 feet from the west door down the nave has been clear, because the “processional stones,” fifty-two in number, extend so far. The choir would also be clear, but, except these two spaces, it has quite surprised me to find how the whole Church has been crossed and recrossed by screens both of wood and stone.

I hope soon to forward a new, large, and detailed plan of the Abbey Church. Since I have commenced taking measurements and drawings, and looking after the man making the moulds, I have accumulated a quantity of interesting matter and details, which I hope shortly, through the kindness of Captain Smith, to lay before your Lordship.

Ripon, 22nd April, 1854.

MY LORD,

The large traced facsimile of Abbot Huby's Initials (A.D. 1494—1526) which I had the honor to forward the other day was, very recently, taken from the house of Tinsley the Blacksmith, in the Village of Fountains. At some period it had been purloined from the Abbey; and, I believe, has formed some portion of one of the stone screens built in the time of Abbot Huby, in the Abbey Church. This stone is interesting and curious on two or three accounts. The letter M is formed of two serpent-like winged wyverns entwined in close combat. Unfortunately the head of one, and the claw or leg of the other, has been broken off. The H is composed of a stately looking raven, apparently treating with indifference the bite of a winged asp. These letters are decidedly Saxon, or early Norman or English in their character, and it is not unreasonable to suppose that “My Lord Abbot” has selected them from some of the many old illuminated MSS. the Library at Fountains possessed. The crozier, as in other examples of Marmaduke Huby's Initials, passes through the mitre, and the scarf or vexillum that was frequently wrapped round the *staff*, is well expressed. The label, above all, has no doubt borne a *painted* black-letter inscription, but long exposure to the weather has worn away all trace of it. The stone is a piece of tolerably hard flagstone grit.

The drawing of “Brother” Rypon's tombstone, I have taken pains to have delineated with every fracture that occurs on the original, to show how the sepulchral memorials have been shattered by the reckless destruction of the roofs, and by the large stones thrown down from the summit of the walls. This will account for the *non-discovery* of the many gravestones we expected to find on the floor where the centre tower stood. From that valuable record, “the President Book,” we learn that, after the chapter-house was about full, the place of interment of most of the Abbots was the space in the middle transept, immediately in front of the choir screen. The solitary 4 at the conclusion of the inscription on Rypon's tomb, and the character of the black letter, may warrant a practised eye in referring its date to 1504, 1514, or 1524.

Just outside the newly discovered west-porch three beautiful perforated plates of lead have been found; two are exactly alike, and I have taken a gutta-percha impression of one, which I forward by this post. We found a similar fragment of lead in excavating the Abbot's house, but its style of design was a century later than these now discovered, which may be referred to the Decorated Period (A.D. 1290—1390). A like relic was found in clearing out the Abbey at Sawley. The one I have drawn weighs $2\frac{1}{4}$ oz. The other two weigh slightly over 3 oz. each. They are perforated, and

both sides bear the same design. We at first imagined that these curious relics had been used for the purpose of more readily covering the panels of Aumbrye Doors, or fine and small screen work, with elaborate tracery. Supposing the wooden surface to be first coloured with bright vermilion or ultra-marine, this leaden tracery work, well silvered or gilt, would produce a rich effect. But the fact of the plates being *alike on BOTH surfaces*, destroys this theory. They may have been *patterns* moulded, and cast in lead, by the designers in the middle ages, and sold to the Ecclesiastics or their architects, as new styles arose during the progress of Gothic architecture.* At all events, they are very curious and valuable relics, and, if not taken into your Lordship's private collection, will be interesting objects in the Abbey museum.

The workman I have employed to take different casts about the Abbey, has completed moulds for—

Three early English brackets:

The broken figure of the Virgin:

Two bas-relief sculptures of the Evangelists:

The Lombardic Inscription on Abbot John de Cancia's tomb:

The Initials of Abbot Huby:

A niche and canopy, containing the figure of an Angel holding the arms of the Abbey; this is above the lowest east window of the tower. Some lesser objects I cannot now clearly remember, as I have not all the moulds in my possession.

The workman is now employed on a small figure above the lowest large north window in the tower. It proves to be a crowned female martyr saint, holding a palm branch in the right, and a book in the left hand, (perhaps St. Margaret).

I would draw attention to the fact that the *highest inscription* on the tower *has never yet been decyphered*, partly on account of its position, but more particularly of its decayed condition. I have read portions of it through a good telescope; but it is impossible to make it out clearly, unless an experienced person were face to face with it. It may only be a religious inscription—perhaps a repetition of those below—but, to judge from other examples I have read of, and seen, it is not improbable that it may contain some information of importance, historically, as regards the Abbey. A similar black letter inscription on the south west tower of York Cathedral bears the name of the "*Treasurer*," John Birmingham. With a little scaffolding, from the top, this inscription at Fountains might easily be reached, and read.

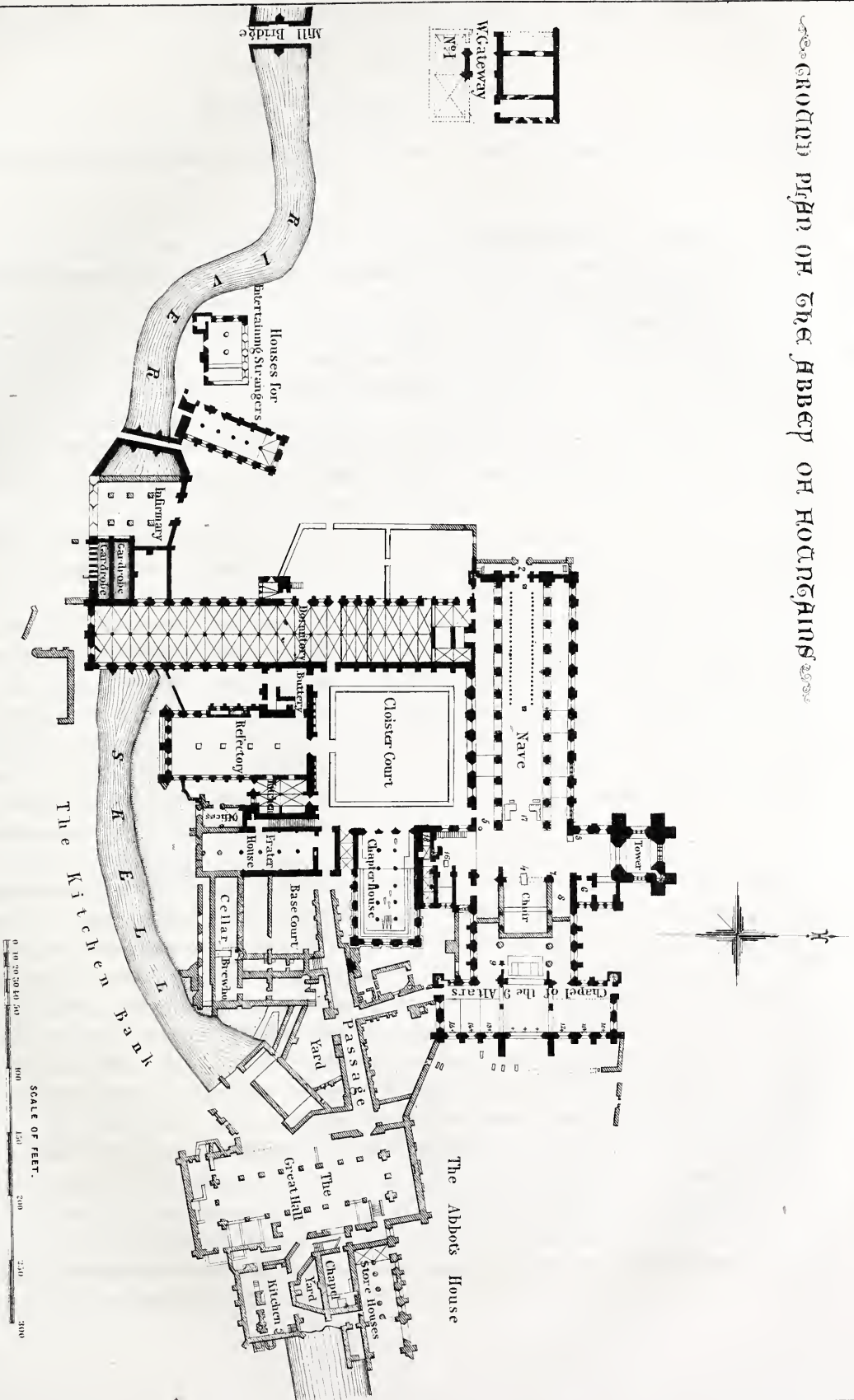
In conclusion, I would add, that I sincerely hope and trust that the noble and spirited example set by your Lordship, not only in this *great* work, but also in the lesser one on the banks of the Ribble, will be speedily followed by other proprietors of our monastic remains. The time has arrived when this should be accomplished. Very few Abbeys now present the same appearance as those of Fountains, Sawley, and Jervaulx. It is sad to call to mind the present state of Byland, Rivaulx, Kirkstall, Mount Grace, Guisborough, Easby, Coverham, and a score of others I could mention. Their storied pavements, the tombs and graves of our old patriots and dignified ecclesiastics; and the architectural fragments of their superb but "bare and ruined choirs," yet lie shrouded in the rubbish which "an undistinguishing reformation has heaped on their heads."

Your Lordship's obliged and obedient Servant,

WILLIAM HARRISON.

* Professor Willis has clearly proved to me that these perforated lead plates are nothing more nor less than ventilators; and he has seen similar specimens yet occupying their original position in old windows.

THE GROUNDS PLAN OF THE ABBEY OF HOUNSINGHAM



ON THE INFLUENCE OF SOME EXTERNAL AGENTS ON THE DURABILITY OF BUILDING MATERIALS.

By GEO. R. BURNELL, C. E.

Read at the Ordinary General Meeting of the Royal Institute of British Architects, June 5th, 1854.

When the very imperfect state of that part of meteorology which treats of the constituent parts of the atmosphere is considered, it cannot be a matter of surprise that little is known to guide us to any definite conclusions as to the causes which affect the durability of building materials, and to their modes of action even under ordinary circumstances. Experience and tradition are the only authorities upon a subject of such importance; and the rules at present adopted in the selection and employment of the various classes of building materials can hardly be considered other than empirical. In the following article it will, therefore, be my object merely to state what is known and acted upon; and at the same time to call attention to some phenomena which require explanation.

The influence of the atmosphere upon building materials is of a complicated nature; it is chemical, mechanical, and *medial*, under which term are included all the various modifications produced by moisture, heat, and electricity.

The chemical influence, or, in other words, the decomposition determined by chemical affinity, depends, of course, upon the composition of the atmosphere itself, and this is known to vary in an extraordinary manner in different localities. The normal composition of atmospheric air is considered to consist principally of oxygen and nitrogen, in the proportions of 208 of the former to 792 of the latter; but there are also numerous other gases present, such as the carbonic acid, ammoniacal, hydrochloric, nitrous, and sulphuric, with sulphuretted hydrogen; the proportions of all which are affected by local causes. Even in the same locality the composition varies with the elevation above the ground, and the application of some theoretical deductions have led to such signal failures, as to justify us in dwelling on the necessity for examining carefully the actual conditions of each position.

It is to Messrs. Dumas and Boussingault that we are indebted for the analysis of the atmosphere quoted above, and from the researches of numerous other philosophers it appears that the proportions of oxygen and azote are constant. Messrs. Boussingault and Levy ascertained that the quantity of carbonic acid gas varied from 3.253 to 2.989 parts of gas (in volume) in 10,000 parts of air, the former result having been obtained at Paris, the latter at Andilly, near Montmorency; but Michel Levy states that the quantity of this gas in suspension varies between 4 and 6 in 10,000, the smaller quantity being that most frequently found in the open country. Carburetted hydrogen is found most abundantly in the neighbourhood of marshes; nitrous acid gas in districts which are subject to violent storms, and it is supposed to be generated by the decomposition of azote by electrical action. M. Fresenius (*Ann. de Chim.* 1849, p. 208) states that he found the proportion of ammonia in the air to be in 100,000 parts in volume, 0.133 ammonia, 0.205 oxide of ammonium, and 0.379 carbonate of ammonia. But M. Boussingault's observations upon the quantities of ammonia in rain water show that it varies notably according to the position, from 1 to 5.45. Under all circumstances the air of the night is richer in ammonia than that of the day, a fact which may be accounted for by the theory of the nutrition of plants, and the precipitation of ammonia by the early morning dews.

M. Chevalier (*Journal de Pharmacie*, 1835) found that the atmosphere of London contained sulphuric acid, generated no doubt by the combustion of coal. The same author also observed that the atmosphere of Paris contained the acetate and the hydro-sulphate of ammonia, which are to be attributed to the exhalations from the numerous cesspools of that town. M. Vogel, of Munich, has the merit of having ascertained the presence of hydrochloric acid in the atmosphere surrounding the waters of the Baltic and the Mediterranean. The action of the sea breezes upon some building materials, to which I shall have occasion hereafter to refer, appears to prove that this gas is not confined to those seas. As it is furnished by the evaporation of the ocean, it necessarily varies in quantity according to the season; and we may also suspect that other deleterious gases are from time to time suspended in the atmosphere, though their existence can hardly be demonstrated on account of their minute proportions.

The meteorological conditions of the atmosphere are subject to periodical variations, and they have distinctly marked phases of day and night, unless extraordinary phenomena occur. Thus, in clear weather the atmosphere attains two maxima and two minima in its electrical state; the first maximum being between seven and nine in the morning, and the second between seven and nine in the evening; the first minimum about four in the morning, and the second between five and ten in the evening; but it must be observed that its hygrometric state frequently modifies these periods. The intensity of the sun's light, and necessarily of its actinic influence, has its maximum rather before mid-day, and two minima corresponding nearly with the periods of twilight. A maximum occurs in the temperature about two o'clock in the afternoon upon the average of the year, but there is a slight irregularity according to the seasons; a minimum occurs, generally speaking, when the sun occupies a position about $14^{\circ} 47'$ below the horizon, according to M. Bouvard's observations in Paris; the period of mean temperature varies in the different months. The atmosphere is driest about mid-day, and contains the greatest amount of moisture at night; the deposition of dew takes place to the greatest extent between midnight and sunrise, on account of the greater cold which then prevails. In our latitudes the disturbances of the barometric action are not marked by any regularity; but there is a tendency to increase in the morning, when the barometer generally rises; it falls about mid-day, rises again about sunset, and falls once more about midnight. It may, in fact, be considered that the meteorological fluctuations of every day are affected by the relative positions of the sun and the earth, and that they correspond more or less closely with the cardinal positions of the former at rising and setting, at mid-day and midnight.

The mean temperature of London throughout the year is $50^{\circ}.50'$, whilst that of the surrounding country is $48^{\circ}.50'$. The thermometer very rarely rises above 96° , and the greatest cold hitherto recorded in our metropolis is 5° . below Zero. The mean barometric range amounts only to 2.07in.

One of the most important conditions of the atmosphere depends upon the rate of evaporation, and the amount of humidity in suspension; and the intensity of these agents is greatest at directly opposite seasons of the year. Evaporation is greatest in summer, and least in winter; the reverse takes place with respect to humidity. Mr. Daniell estimated the mean evaporation in the neighbourhood of London at 23.974 inches per annum, ranging in the various months from about half an inch in January and December to $3\frac{3}{4}$ inches in June, and $3\frac{1}{4}$ inches in July. Supposing the complete saturation of the atmosphere to be represented by 100; the humidity of the months of December, January and February will then be expressed by 92. In the intervening months the humidity diminishes with tolerable regularity to the minimum of 78 at the end of June, except in the month of May, when a trifling irregularity occurs. It thus happens that the greatest amount

of moisture is suspended in the air, to be absorbed by porous materials, precisely at the season of diminished temperature and exposure to the attacks of frost; while evaporation takes place at the period when the conditions of temperature are most favourable to the production and development of the salts by the previously absorbed moisture acting on the earthy bases.

Such we may consider the general properties of the atmosphere likely to affect the conditions of building materials, and we may trace their influence under circumstances apparently very dissimilar.

The various external agents produce effects, either by the new combinations they superinduce between the earthy bases, the metals, and the metalloids of the different classes of building materials and the gases they contain; or by the solution and removal of the combinations previously existing. There are few, indeed we may almost say that there are no conditions either of organic or inorganic chemistry which can be considered permanent; and as the gradual decay of rocks is a law of nature everywhere, and inevitably, at work to renew the face of the world by apparent destruction, it is not to be expected that the insignificant quantities we deal with can be exempt from similar laws. The consideration of the circumstances attending the formation of the new compounds of oxygen, hydrogen, carbonic, ammoniacal, and hydrochloric gases with the bases above mentioned; with the action of the fermentation of woody sap, would lead to a lengthened investigation of the most abstruse branches of chemistry. The importance, however, of these compounds cannot be too strongly insisted upon, nor can the attention of scientific men be too decidedly called to them. Sometimes they act to destroy, at others to consolidate; but in all their influence is very marked, and calls for serious consideration from the architect. Limes, cements, and some descriptions of building stones, when properly employed, gain in strength and durability by the slow, but sure, action of the air. When injudiciously employed they rapidly decay, through the decomposition to which that element gives rise, or the mechanical agents to which it serves as a medium; while the destruction of the metallic or the organized matters employed, is equally occasioned by the same cause. I shall now proceed to point out the various phenomena exhibited by the respective classes of building materials usually employed in London, not attempting, however, more than a very general description of a subject so vast, and at the same time so complicated.

Granites present many varieties, differing greatly in their composition and the mechanical arrangement of their elements. Those from Devonshire and Cornwall contain a large proportion of schorl, and are frequently pervaded by masses of felspar, of such dimensions, and so distinctly crystallized, as to cause them to assume a porphyritic character. According to Sir H. De la Beche, the granites of Ireland are of the same character, but the schorl occurs in smaller proportions. The granites of Aberdeenshire are more decidedly micaceous, and schorl is rarely found in them; they also differ from those of England and Ireland, in having their component parts more equal in volume, and more evenly distributed. In some cases hornblende takes the place of mica, and in others the quartz and the felspar are both so much affected in colour by the presence, doubtless, of hydrous oxide of iron, as to give a general rosy hue to the whole mass. An instance of this is the well known granite of Peterhead. The granites of Guernsey, Jersey, and the Isles Chausey, which are occasionally brought into the London market, resemble those of Cornwall; and, indeed, Mc'Culloch, in his "Classification of Rocks," states that they pass into the same variety. Their appearance is, however, sometimes diversified by the occurrence of large imperfectly shaped crystals of compact felspar, which give the whole mass either a greenish tinge, as in the case of the Guernsey, or a rosy one as in that of the Jersey granite.

The decomposition of granites takes place from the action of the atmosphere upon their con-

stituent particles. "The quartz is almost pure silicious earth, in a crystalline form. The felspar and mica are very compounded substances; both contain silica, alumina, and oxide of iron. In the felspar there is usually lime and potassa; in the mica, lime and magnesia. When a granitic rock of this kind has been long exposed to the influence of air and water, the lime and the potassa contained in its constituent parts are acted upon by water and carbonic acid; and the oxide of iron, which is almost always in its least oxidized state, or in that of the protoxide, tends to combine with more oxygen; the consequence is that the felspar decomposes, and likewise the mica, but the first the more rapidly." Such are the words in which Sir H. Davy (*Agricultural Chemistry*, p. 189) describes the mode of decomposition of granites; and they may be taken to express the present state of science so far as the granites usually employed in England are concerned. But there appear to be different conditions in the combinations of the bases of felspar which give rise to some apparent anomalies. Thus, the Egyptian porphyries, which contain a notable excess of rose-coloured felspar, resist the influence of the atmosphere in an extraordinary manner. Possibly this may be accounted for by the closeness of the grain (so to speak), which would to a certain extent prevent atmospheric moisture from communicating with anything beyond the immediate surface; or the more simple character of some of these porphyritic rocks may be favourable to their preservation; whereas the different rates of expansion of the ingredients must have a material mechanical influence in disintegrating rocks when they exist in considerable numbers. The difference between the rapid rate of decomposition of the porphyritic granites of Spain, Britany, and Cornwall, and that of the Egyptian specimens appears to justify the inference that the cause last suggested has great influence upon their durability. The former are, in fact, composed of a greater number of ingredients than the latter, in which both mica and hornblende are wanting.

Practically it is found that the uniform character of the Aberdeen granites resists atmospheric influences in our latitude better than the more easily worked stones of Devonshire and Cornwall.

It may, perhaps, be as well to call attention to the fact that the modern application of the term "porphyry" is in some cases inconsistent with its derivation; the *grey* granites of Devonshire, Cornwall, and the N. W. of Spain, being occasionally called porphyritic, as well as the *purple*, felspathic rock of Egypt. The latter is almost entirely composed of felspar, with occasional crystals of amphibole and quartz; but the colour is entirely owing to the felspar, which is of a beautiful purple occasioned by the presence of a large proportion of the hydrous oxide of iron. Ophite (green antique porphyry), and melaphyre (black porphyry) are instances of a similar disregard for the derivation of a generic name. A description of granite, known to mineralogists by the name Syenite, was also much used by the ancient Egyptians; it is remarkable for having the mica replaced by hornblendish amphibole, and is of a rose colour. The atmosphere does not appear to have much action upon this variety, at least in Egypt, if we may judge by the state of Pompey's Pillar, and Cleopatra's Needle.

Whinstones, or basalts, become disintegrated unequally under the effects of exposure to the atmosphere, in consequence of the variable proportions of felspar they contain, and perhaps also of the particular combinations of alumina, lime and magnesia, which, in connection with silica, constitute their base. If any potassa be present in combination with the silica in the shape of felspar, the action is more rapid than under ordinary circumstances, the humidity of the atmosphere decomposing the felspar into two substances, one of which is soluble, and easily removed by succeeding rains. Serpentine, and the diallage rocks, which are silicates of magnesia combined with hydrates of that base, yield easily to the attacks of acids when the silicates are in certain proportions, and alumina is present. The most beautiful varieties of these materials employed in the arts are obtained

from the environs of Genoa, and from Zöblitz in Saxony; but it is much to be feared that the atmosphere of large towns, especially when containing sulphuric acid gas from the combustion of coal, renders the employment of even the best of these decorative materials very hazardous. It appears also that in parting with their water of crystallization upon exposure to the air, an unequal contraction takes place in the constituent parts of the serpentine obtained in certain localities, which in consequence breaks in an irregular manner.

The next description of building materials to be considered, in following the ascensional order of the geological series, are the slate rocks. Those worked for the supply of the London market are principally situated in North Wales, Cumberland and Westmoreland, the former being a tolerably homogeneous clay slate, the latter being much more chloritic. Exposed freely to the action of the atmosphere both varieties appear to be tolerably durable, but Westmoreland slates decay very rapidly in damp positions, when the air around them is not frequently renewed. They decay, in fact, in the covered parts, probably from the decomposition of the silicate of iron to which they owe their peculiar colour. The combination of silica and alumina in the Welsh slates appears to be more stable than that which prevails in any other material of the same nature; for their powers of resistance to atmospheric influence are greater than those of any slates employed in Western Europe, or North America. As a general rule, the denser the slate the more durable it will be; and the most important condition to be observed in its use is that water should not be allowed to percolate between the edges of the strata. Practically it is found that the smoother the surfaces of the slates, and the closer they lie, the greater is the pitch requisite to be given to the roof; because, under such circumstances, capillary action takes effect to a greater extent than when the slates present irregular and perceptibly large intervals.

The various sandstones, millstone grits, and conglomerates, are affected by the atmosphere, either through the decomposition of the material cementing their particles together, or by the mechanical effects of moisture. These last may consist, either in the removal of the cementing material, or in the destruction of the cohesion of the particles by the expansion of the water in freezing. Many of the sandstones occur in regular layers, separated by thin films of a species of clay, as in the common Yorkshire flagstones, and when these films are sufficiently thick to offer an efficient resistance to the passage of water, to retain it in fact under the upper shale, the expansion during frost will almost inevitably destroy the stone. If the water should change its form from other causes, such as heat, the same effect will be produced; and it is therefore found that the Yorkshire stones of a very porous, and at the same time of a very fissile character, are unable to resist the extremes either of cold or heat. The best materials of this description are those of an homogeneous nature—such as the Park Spring, the Idle, and the Darley Dale stones, in all of which the minute subdivisions disappear, and the mass may be described as consisting of an assemblage of distinct molecules of similar nature, united by mechanical juxta-position.

The sandstones, in which the silicious molecules are united by a calcareous cement, are far more susceptible of decomposition than those united by a silicious cement, for it appears that in the former cases the chemical combination is rarely effected between the lime and the silica; as the latter is not in the state known as free silica, nor such as can easily form combinations with other materials. In the case of some of the millstone grits, however, the cementing substance, which is silicious, forms so energetic a combination with the molecules it envelopes, that both resist the action of external causes in an equal manner, and the durability of the Bramley Fall stone may fairly be compared even to that of granite itself. These remarks may be extended to the conglomerates, in all essential respects at least, because in fact, generally speaking, they differ from the millstone grits only in the size of their elements.

The crystalline marbles vary in such a very marked manner, both in the nature and the proportions of some of their constituents, and they have been so modified by the accidental circumstances of their geological position, that it is more than usually difficult to trace the laws of their decomposition under the action of atmospheric causes. In many instances they are traversed by veins filled in with more perfectly defined crystals of the base of the rock, or the fissures caused by these veins are filled in with extraneous matters, such as clay, and sometimes even with minerals. Again, however regular the structure of the mass may seem, there is always a tendency in the more crystalline rocks to assume a distinct cleavage, which is often different from the direction of the planes of stratification. Under such circumstances, the moisture furnished by the atmosphere either furnishes the elements necessary for the decomposition of the materials introduced into the veins, or by the mechanical effects it produces in consequence of the changes of temperature, disintegrates the mass. The former class of phenomena may be most distinctly observed in the Breccias, or such marbles as the Brocatello and the Oriental Jasper; the white marbles very frequently exhibit the cleavage above alluded to, and are the most exposed to the injuries produced by the infiltration of water between the planes of division. It is to be observed that the species of false stratification indicated by the cleavage is most apparent in the rocks which, like the slate rocks, have been affected by proximity to igneous formations, and that the more crystalline the marble the more exposed it is to this inconvenience. At the same time it must be observed that the more perfectly crystallized carbonates of lime, under which denomination in fact nearly all the finer marbles may be included, resist the chemical influences of the atmosphere more successfully than similar substances where the forms are not so distinctly marked. It would appear as though the process of crystallization were accompanied by the development of some chemical affinity between the ultimate particles, similar to that which is noticed with respect to the various forms of silica, and which enables them afterwards to resist more energetically external causes of decay. In some marbles the joints assume different directions from either the lines of stratigraphical deposition, or from the planes of cleavage; but in the practical operations of building the consideration of this peculiarity may be neglected, because they are usually so distinctly marked as to place in reality the natural limits to the sizes of the blocks raised.

M. Durocher communicated to the Académie des Sciences a memoir "sur l'absorption de l'eau atmosphérique par les substances minérales," which throws some light on the subject of the decomposition of silicated materials, or those containing metallic oxides. From his experiments it appears that all substances of this description actually absorb water from the atmosphere, and undergo a commencement of hydration, which must necessarily facilitate the decomposition of mixed minerals, such as the silicates, and is apparently the commencement of that action. Messrs. Jamin and Bertrand have also shown that in porous bodies gasses are condensed with remarkable facility, so that it is possible that the conditions of molecular aggregation influence the durability of mineral substances in the direct proportion of the facilities which are offered to the passage of air to the interior. From this we may infer that the existence of a crystalline structure is in itself a protection to the materials in which it may occur, because under such circumstances the porosity is usually less; or at any rate the intervals between the ultimate molecules are proportionally smaller than in the case of materials held together simply by aggregation without crystallization. Sir H. De la Beche notices the universality of this law (*Geol. Observer*, ed. 1851, p. 8), but he does not attempt to account for it.

The magnesian, the oolitic, and the ordinary secondary and tertiary limestones, are liable to decay under the influence of the atmosphere with very various degrees of rapidity; and it is,

moreover, to be noted, that the same formations yield materials varying singularly in their powers of resistance according to the position they occupied in the quarries, and the exposure of the building in which they are employed. The results obtained by the use of the Anston magnesian limestone, and the marked differences to be observed in the Bath, Caen and Portland Oolites, as well as in the several members of the tertiary series of the Paris basin, appear to show that no *a priori* laws can be laid down with respect to their durability when exposed to the air. All these classes of materials are supposed to have been deposited by waters containing their elements in solution, and if they were once in that state (*i. e.* of solution) it must be evident that they are always susceptible of passing into it again, if the necessary conditions are presented, unless the deposition should have been effected by the introduction of some additional element, or such element should have been supplied at a later period. There is another chemical agent at work in many cases to hasten the decomposition of the sedimentary rocks unaffected by Plutonic action, namely—the animal matter which they so often contain; and as the distribution of this matter is not subject to any definite law it necessarily produces irregular effects. Occasionally, also, the body of the stones is traversed by numerous fissures which have been subsequently filled in by more crystalline materials of greater powers of resistance; and again, the chemical nature of these stones often varies, owing to the presence of more or less silica in combination with the ordinary bases. Every possible variety in the mode of disintegration may therefore be observed in these stones.

Experience has shown that the magnesian limestones are not more capable of resisting the effects of our London atmosphere than the carbonates of lime formerly used, when proper care has been exercised in the selection of the latter. Mr. Rogers indeed remarks (Brit. Assoc. 1849) that rain-water slightly carbonated takes up the carbonate of magnesia more rapidly than it does the carbonate of lime, and that the magnesian silicates are easily soluble even in pure water. Forchhammer also observes, that water which contains carbonate of soda acts easily upon magnesian rocks. Now it is very probable that the rain-water falling through the atmosphere of London should be charged at any rate with carbonic acid gas, and thus become extremely prejudicial to this class of materials; and it is possible that the rain may give rise to a catalytic action between the lime and magnesia contained in this class of stones, which would facilitate their decomposition. Every stone, as may be gathered from what has been said above, is exposed to decay in the precise ratio of its porosity, but in addition to this cause of disintegration, which acts principally by allowing water to exercise its natural mechanical powers, all the ordinary building stones are exposed to the peculiar process known by the name of nitrification, which, in consequence of the formation of the crystals of nitre, combined with a base, tends to disintegration of the surface. The magnesian limestones allow the development of this process as freely as the carbonates of lime, even if they do not offer extraordinary facilities for its action. The generally received opinion is, that the azote, furnished by the decomposition of the animal matters diffused through the rocks, combines with the oxygen of the atmosphere to form nitrogen, which latter gas in its turn combines with the soda, existing in small quantities in all sedimentary deposits, to form the nitrate of soda, or the saltpetre of commerce. Dumas says that azote and oxygen combine most readily under the influence of electricity, but that the energetic bases, lime and magnesia, may suffice, especially when moisture is present, to replace that intermediate agent. At any rate this chemical operation takes place in nearly all building stones of a porous nature, and it may confirm the common opinion that of stones, of the same description geologically, the densest are the most likely to resist the action of the atmosphere.

The phenomena of the saltpetrifying of building materials are very little understood; but there are certain practical rules which may serve to guide the architect in his endeavours to avoid the incon-

venience arising from it. They are, first: To employ, if possible, in damp positions, either granite, the mill stone grits, the conglomerates of a purely silicious character, or sandstones free from animal matter, and the sulphate of iron.

Secondly. If the cost of either of these classes of materials should render their employment impracticable, the use of any of the ordinary limestones should be avoided in positions where they are exposed to warm dampness, should it be desired to execute any coloured decorations upon the immediate surface of the walls. When from local considerations it may be advisable to employ these materials in basements, or other damp positions, they must be separated from the upper structure by the interposition of a layer of some impermeable material, to intercept the passage of the water, which would otherwise be absorbed by the capillarity of the upper stonework.

Thirdly. Every precaution must be taken to prevent the saturation of the ordinary limestones by sea water, and the use of sea sand in the mortar to be employed with them must be carefully avoided, because sea water furnishes the salts of soda most likely to assist in the formation of the nitrates, and sea sand is also highly impregnated with the same salts. It is equally known that the atmosphere of the sea shore holds in suspension a notable quantity of the various salts which pass off by evaporation from the surface of the sea, and it is for this reason that stones which are exposed to nitrification suffer more rapidly in such positions than in the interior of the country.

Fourthly. To isolate decorative works effectually from the walls formed of materials in any way susceptible of saltpetrifying. Of late years attempts have been made in Paris, and some other continental towns, to revive the practice of mural decorations, but the results have generally been unfavourable, in consequence of the chemical action of the atmospheric moisture transmitted through the pores of the stones. So seriously has this cause been observed to affect internal decorations, that the architect of the new Hôtel du Ministère des Affaires Etrangères, M. Lacornée, has lined the inner surfaces of the walls destined to receive either silk panels or paintings with sheet lead, and has then battened out independently of them. In the new church of St. Vincent de Paul the painting on the dome behind the high altar has begun to fade from the effects of the transmission of the moisture of the atmosphere through the stone vaulting. This work has not been executed more than about twelve months.

It must be observed with respect both to the carbonates of lime and the magnesian limestones, that their principal elements exist only in the state of subcarbonates while the stones remain in the rock. They absorb carbonic acid from the atmosphere, and harden by exposure to the air; but as the hardening process would augment the cost of labour, and is moreover very slow in its action, it is rarely resorted to in practice. For many reasons, however, it would be desirable to quarry the stone required for an important building twelve months before it is to be employed, because the danger to be apprehended from frost would be avoided, and the carbonization would be more perfect. Another very useful precaution is to cover the exposed surfaces with a wash of some description, able either to close their pores or to produce a chemical action on the stones themselves. The practice of some London masons of painting the stone work as it is carried up, with a thick slime of stone dust and water, acts in the former manner; the washing all exposed surfaces with an alkaline silicate acts in the latter, and it would be unquestionably preferable were it not that in some positions the addition of even the small quantity of soda, requisite to hold the silica in solution, might furnish the element of the saltpetre.

Of late years attempts have been made to cast doubts upon the correctness of the generally received opinion, that it is essential to place stones on the same bed as they occupied in the quarry. With some few stones when in place, it may be true that the position of the layers is a

matter of indifference; for the roche de St. Cloud, and the Villebois stone of the neighbourhood of Lyons, amongst the secondary and tertiary limestones, have been employed without reference to the planes of bed for many centuries without inconvenience. But these cases are decidedly exceptional, and even in them the powers of the stone to resist a crushing weight are less when it is applied in a direction parallel to the beds, than when it is applied transversely. In almost every other case it will be found that when stones are used the wrong way of the bed, to employ a workman's phrase, they disintegrate in parallel plates. Great care requires to be exercised to ascertain the precise direction of the natural beds, because many stones present the appearance of inclined planes of deposition, which cut the beds and joints under every modification of angle. When from the stones having been worked in the quarry it is difficult to ascertain the precise bed, it is possible that the mason may be misled by the greater facility with which they work in one direction, and may mistake this cleavage for the real bed. The only remedy appears to be to cause the stones exposed to this danger to be marked in the quarry, but fortunately the examples of its occurrence are rare.

The principal danger of exfoliation arises from the expansion of the moisture contained in the stone under the influence of frost, and a very elegant process was invented by M. Brard, for the purpose of ascertaining the probable extent due to this cause. M. Brard in his experiments upon the resistance of stones, caused them to be boiled for half an hour in a saturated solution of the sulphate of soda. They were then withdrawn and allowed to stand in a flat vessel, at the bottom of which was a small quantity of the same solution, the first efflorescences were washed off, and the degradation of the stones during the next five or six days, under the effects of the continued efflorescence, were taken as an indication of the probable extent to which they would be affected by frost. In the first volume of Rondelet's *Art de Bâtir*, page 307, (ed. 1842, Paris), M. Brard's process is described in detail; but some very curious experiments recorded in vol. 7, 1^{re} serie des *Annales des Ponts et Chaussées* by M. Minard, together with an article by M. Vicat, inserted in the same volume, throw very considerable doubts upon the exact amount of dependance to be placed on its indications. M. Vicat, indeed, very properly observes, that it still remains to be proved that the expansive action of water in freezing is identical with that of crystallization, which can only produce energetic effect at temperatures between 68° and 86° Fahr. According to this very accurate observer, stones which are exposed to a southerly aspect, on the north of the equator, are more affected by frost than those exposed to the north; and the most efficient protection to materials of this description of a porous nature is a coating of oil paint, or any other fatty pigment which prevents moisture from being driven or absorbed into the stone. M. Minard recommends that stone should be quarried in the spring, and not employed in a building until it has been exposed to the effects of one winter at least.

In many varieties of the oolites, the fossil shells are to be observed left in high relief upon the surface by the decomposition of the materials in which they were embedded, and in Bath stone the veins of calcareous spar frequently become detached. It appears that the cause is the same in both cases, and that the shells and the veins protrude in consequence of the resisting powers of the more perfectly crystallized carbonate of lime, of which they are composed, exceeding those of the amorphous mass in which they are embedded. When nodules of flint or chert occur in the numerous varieties of carbonate of lime, the stone around them is usually more durable than the general mass of the rock, doubtless because it contains a portion of the silica in combination with the lime. It is known, indeed, that the application of a soluble solution of silica will at all times add much to the durability of the purer carbonates of lime; but it is very desirable that the con-

ditions under which such a solution should be employed should be made the subject of close and careful experiments.

There are some varieties of arenaceous limestones and sandstones with calcareous cements, and a very remarkable silicious deposit, to be met with in the upper secondary and tertiary formations, which may eventually serve to throw light upon the chemical changes produced by the atmosphere in consequence of the very decided character they assume. For instance, the sandy beds of the Kentish rag perish in consequence of the mechanical removal of the sandy cement which binds together the particles of limestone. The grès or sand stones of Fontainebleau and Windsor forest as frequently decompose, in consequence of the removal of their calcareous cement by moisture, or by the action of the air; whilst the silicious beds of the lower chalk appear likely, from Mr. Way's experiments, to furnish materials of inestimable value to plastic art, and also affording a convenient and economical supply of the soluble silica required to compensate the deficiencies in other more generally employed materials.

With respect to the gypseous formations, it appears that where they occur in sufficient abundance to be used as ordinary building materials, they absorb moisture from the atmosphere with extraordinary facility; while they decompose with such rapidity that the municipal authorities of Paris have forbidden their being used for the walls of houses. Occasionally, however, rubble plaster stone is used for enclosure walls, but it rarely lasts more than from twenty to thirty years, when exposed to the weather near Paris. The cause of this rapid decay, according to Gmelin, is to be found in the fact that the sulphates with an earthy base (gypsum being a sulphate of lime) are soluble in water. It is also to be observed that many of the gypseous deposits, especially those found near Paris, are impregnated with an extraordinary proportion of organic matter; this decomposes on exposure to the air in warm and damp positions, and gives rise to the formation of nitrous salts to such an extent, that the saltpetre used by the French powder manufacturers, during the last war, was almost entirely obtained from cellars constructed of rubble masonry, set in plaster in the style usually adopted in France. It is possible that the gases which are present in rain water, or in the atmosphere, may give rise to a species of decomposition by relative affinity, in combination with the sulphuric acid of the gypsum.

Atmospheric influence upon bricks, tiles, and other building materials obtained by the burning of plastic clays, depends very much on the chemical composition of the clays, and on the degree of burning. Thus any distinct portions of limestone present in them would be converted into quick lime in the kiln, and when the bricks were thoroughly wetted would expand in such a manner as to disintegrate the mass. If the clay used is too poor, that is to say, if it contains an excess of sand, the bricks will not become sufficiently fused, and upon exposure to the weather their constituent parts will separate. It is to be observed that in bricks, as in stones, decomposition does not take place with the greatest rapidity where constant moisture exists, but rather where, from the influence of capillarity, variable according to the moisture furnished by the atmosphere either directly or indirectly, a series of alternations of dryness and humidity prevail. The foundation walls of buildings do not in fact suffer so much in the parts immediately upon the ground, as they do in those at a height of from one to three feet, according to the permeability of the materials employed. When bricks made of clay containing free silica are laid in mortar, and moisture can pass freely from either one or the other, it may be observed that the edges in contact become harder than the body of the bricks. No doubt this arises from the formation of a silicate of lime and alumina, the lime being furnished by the passage of the water through the bed of mortar.

Upon limes and cements the effects of the atmosphere are very marked, although at present

they are considered to be of far less importance than formerly. All the materials of this class, whether the hydraulic, or the rich limes, the cements, or the plasters properly so called, have a remarkable avidity for water, and abstracting it from the surrounding atmosphere assume the form of hydrates. If these occur in the conditions requisite to enable them to pass into the carbonates, or sulphates, a species of confused crystallization, or aggregation, takes place. But it must be evident, from what was said in the commencement of this notice, that the quantity of carbonic acid gas the atmosphere is capable of furnishing within a moderate period is exceedingly small, and the theory that limes or cements harden originally by the absorption of that gas, and the consequent conversion of the lime into carbonate of lime, must be abandoned. There can be no doubt but that the conversion of the lime into the carbonate must increase its cohesion, but the rapid setting, to use a workman's phrase, cannot be accounted for in this manner. It appears, so far as we are able to judge in the actual state of applied chemistry, that mortars harden in consequence of the formation of an insoluble silicate of lime and alumina, the silica being either furnished by the limestone itself, or by the sand, pozzolano, or other ingredient mixed with the slacked lime. When the setting has been once effected, the absorption of carbonic acid gas from the atmosphere may tend to harden a thin external film; but the very perceptible character of this film militates against the supposition that the cause producing it can act upon the interior of the mass.

Nevertheless the numerous classes of limes, cements, and plasters, exhibit very marked differences in their manner of resisting the action of the atmosphere. The purer carbonates of lime when used for the preparation of mortar, are excessively soluble in water; and if the mortar obtained from them be much exposed to the weather, or to the action of running water, it will be rapidly removed. The argillaceous limestones, on the contrary, furnish the elements necessary to form an insoluble double salt of lime with the silica and alumina; and if the mortars made from them be protected from running water during the period required for their setting, the action of either weather or running water subsequently will rather tend to increase their powers of resistance. The practical lesson to be drawn from these facts would appear to be, that none but the limes obtained from argillaceous limestones should be employed in damp situations. With respect to the use of plaster, the observations before made upon the gypseous stones will apply here perhaps with even greater force. Indeed the marked difference between the external aspects of the applied plaster and the natural stone, would show that in the process of calcination some element we are unable to ascertain must be driven off. It may be that the burnt plaster yields more readily on account of the absence of this very element; but certain it is that plaster of Paris very rapidly decays when exposed to the influence of the atmosphere.

Temperature appears to act in a distinct manner upon limes and cements, for if they are used in summer, without the adoption of any precautions to defend them from the sun, they invariably crack; and of course, if their water of crystallization becomes frozen in winter, the whole mass will disintegrate. The more rapidly limes or cements solidify, the more they appear to be exposed to the danger and inconvenience of cracking in warm weather, and it would appear that the most favourable condition for their resistance is when a certain degree of uniform moderate dampness prevails. It must also be observed, that sea air has a marked influence upon the durability of some limes, because the minute particles of sea-water it contains hold in solution many salts with which free lime has more affinity than with silica.

The decay of wood superinduced by atmospheric action, is affected by a different class of phenomena from those which tend to destroy stones and metals, namely, those connected with

organic chemistry; although at the same time the changes produced by inorganic elements are as powerful in the one case as the other. From the day when wood is felled to the day it is used, it requires care and attention, and when it is in place, precautions should still be taken to ensure its durability. Currents of air which are either renewed with too great rapidity, or are too dry, a temperature too elevated, constant moisture at high temperatures, alternations of dryness and humidity, absence of ventilation producing wet rot, the accidental transport by the atmosphere of the seeds of certain cryptogamous plants producing dry rot, and the attacks of insects, together with the fermentation of the sap of the trees, may be cited amongst the numerous sources of danger from which it is necessary to secure wood either when in store, or when employed.

When wood is exposed to frequent currents of air, especially at high temperatures, the moisture it contains evaporates too rapidly, and gives rise to cracks and fissures which either destroy the resistance of the material, or open a passage for the water contained at other times in the atmosphere to penetrate to the interior of the mass. If the temperature to which wood is exposed, whilst any sap remains in it, is too elevated, the vegetable fluids ferment; the tenacity is diminished, and when the action is carried to its full extent, the wood quickly becomes affected by the dry rot. Exposure to the atmosphere in positions where rain can lodge in quantity, contact with the ground, and application in damp situations deprived of air, will render wood liable to the wet rot; and however well seasoned it may have been previously to being brought within the influence of any of these causes, it will infallibly suffer. It is therefore of the highest importance, that whether in the merchants' stores, or subsequently when placed in a building, wood should be preserved from contact with the ground, and that air should have free access to it in every direction. The germs of destruction are often communicated whilst the wood is in store from neglect of these simple precautions; if they be once implanted, the progress of decay can never be subsequently arrested. It has been supposed that keeping wood in water tends to prevent the commencement of dry rot, because in that position the sap is washed out of the pores. If this theory is correct, it must be evident that the oftener the water is changed, the greater will be the probability of its producing the desired effect, because if it be allowed to stagnate it must become saturated with the sap in course of time, and unable to take up any additional quantity which may be present. Duhamel observed, that if wood were immersed immediately after it was felled, it would be less liable to decay than if put in water at a subsequent period; he also found that immersion tended to preserve the wood from the attacks of insects, and even to arrest the progress of some kinds of decay, but that a notable portion of the strength was lost. The drying and seasoning take place with greater rapidity after immersion, probably because the water displaces the sap, which does not evaporate so rapidly as the thinner fluid. Duhamel asserts that the process of charring the ends of posts, &c., built into the ground, is very inefficient, and that it is only of use to the extent of interposing an extraneous substance between the wood and the earth; in his opinion it would be better to enclose the lower ends in sand, stone, cinders, or other materials which would easily carry off the water supplied by the surrounding media.

When wood is converted and placed in a building, its durability may be greatly increased by covering it with a coating of paint, or other substance which will prevent the moisture of the atmosphere from obtaining access to it. But it is essential that the wood so covered should be free from sap, or internal moisture, or the very perfection of the coating will be found to accelerate its decay. Care must be taken to prevent water from finding its way into the joints, and if the

wood be exposed directly to the action of the sun, it should be painted of a colour able to reflect rather than to absorb heat. It is desirable that it should be planed before being painted, in order that the paint may be applied in an equal manner over the surface. It is important also to observe, that the moisture in the atmosphere not only affects the volume of the wood, but frequently alters the position of the fibres by producing a torsion analagous to that which may be observed in hygrometric cords.

Of late years the processes of Kyanizing, creosoting, and immersing timber in solutions of mineral salts, have been applied with various success for preserving it from rot, and the attacks of worms or ants. Of these, Kyanizing, which employs a solution of deutochloride of mercury, appears to be most satisfactory; and among some striking illustrations of its results may be cited the fence of the Regent's Park; the posts of which were inserted in the ground, without being painted, at least 18 years since, and remain at the present day in very tolerable condition. For railways, and harbour works, English engineers appear to prefer the system of creosoting, or immersing the timber in the rough oil of tar, until it has absorbed at least 7 or 8 lbs. per cubic foot. The difficulty of injecting so large a quantity of oil is overcome by exhausting the sap and moisture from the wood in vacuo, and then forcing in the oil under great pressure; a species of artificial drying is, however, frequently necessary, and indeed the success of this process appears to depend entirely upon the extent to which the original moisture is withdrawn. Both corrosive sublimate, and oil of tar, are capable of resisting the causes of decay communicated by the atmosphere, and the latter is said to be an effectual preservative against the attacks of boring animals; but it is to be feared that the ordinary manner of applying them does not ensure their penetration to a sufficient depth to attain the objects desired. The use of the sulphate of copper, and of the other metallic salts has hitherto been unsuccessful.

In the bent timber bridges which have been constructed on some of the recent lines of railway, although every ordinary precaution was taken in selecting the timber, immersing it in solutions of the metallic salts, and in painting it when in place, the wet rot has exhibited itself in so many instances as to render it almost necessary to abandon a system which appeared to have many recommendations. It is, however, to be observed that these bridges decayed solely because their elasticity caused them to yield upon the passage of every train. The play thus produced caused the joints to open; and moisture, furnished by rain, or the condensation of vapour, found its way into the interior of the beams. The failure of the bent timber ribs in such situations does not, therefore, in any manner affect the propriety of using that construction on more suitable occasions. A valuable lesson is, however, to be learnt from the above fact, viz., that it is difficult, if not impossible, to protect complicated systems of carpentry from the effects of the atmosphere, when exposed to the occasional action of heavy loads able to produce a disturbance of their main parts.

In the theatre at Munich a soluble glass was applied to the woodwork and scenery for the purpose of preserving, and, as far as possible, rendering them incombustible. This glass was in fact a solution of free silica in caustic alkali; and if the wood was properly seasoned, there can be no doubt of the value of the application, especially if it was injected under pressure. Professor Way's researches into the silica beds of the lower chalk prove that a solution of this nature could be obtained easily and economically; and the advantages it offers certainly render its application desirable.

The action of the atmosphere upon metals is even more complicated than that which takes place upon stones, because the electro-chemical changes are more efficient, and the metallic bases are susceptible of combining with a greater number of gases than the earthy bases or the metalloids. In

building operations the metals commonly used are iron, lead, copper, tin, zinc, with the mixed metals, brass or bronze, and to them we will confine our attention.

Iron, whether cast or wrought, becomes rusted on exposure to the air or water under certain conditions; that is to say, the outer portions of the metal are converted into a hydrous oxide, and can be detached in scales, or flakes. Many systems have been proposed to obviate the danger and many substances applied to correct the evil arising from this cause, full information concerning which, is contained in Mr. Robert Mallet's papers in the Transactions of the British Association for the Advancement of Science. His experiments appear to show that gas tar applied hot is the most efficacious for iron work exposed to cold water; and that a coating of caoutchouc varnish resists the longest in hot water; but that neither of them can be considered a durable defence. Cases cited by M. Vicat are within the knowledge of every architect who has examined this class of phenomena, which prove that in some waters, as in some positions in the open air, iron work, totally unprotected, will last an indefinite period. These exceptions are, nevertheless, so rare, and the destruction of iron unprotected is generally so rapid, both in air and in water, that constant care and attention are required to guard against the destructive tendencies of those agents. If iron work be exposed to the air in positions which render the renewal of the latter difficult, and at the same time retain it in a marked degree of dryness, the iron will become covered with a coat of rust, through which the atmosphere cannot penetrate to attack the metal beneath. If the water, in which iron is immersed, contains a very small portion of some of the earthy salts, the decomposition will take place slowly. But it is necessary to observe that these remarks only apply to iron of considerable dimensions: small wires decay rapidly on exposure to either of these causes of disintegration.

Should iron, however, be exposed to confined air in damp positions, the decay attains its maximum. Carbonic acid gas contributes much to this, for, under its influence, iron passes (to use the words of Vicat) into the state of the carbonate of protoxide, which, absorbing fresh doses of oxygen, transforms itself into a hydrated peroxide. It is indeed generally considered that oxidation cannot take place to a dangerous extent unless carbonic acid be present; and it is precisely for this reason that iron, bedded in fresh masonry or concrete, resists the action of the air, because either the mortar absorbs the carbonic gas, which has a greater affinity for lime than it has for iron, or the masonry is sufficiently dense to protect the iron from contact with the atmosphere. The investigations of the Commission in 1850, respecting the fall of the bridge over the Maine, at Angers, (recorded in *les Annales des Ponts et Chaussées*, vol. 29, 2nd series, page 394) appear to prove that the preservative action of the lime depends upon its being in immediate contact with the iron, and that if a space, however small, be left between the two substances, moisture will insinuate itself, and in course of time produce active oxidation. M. Vicat, in a note inserted in the *Annales des Ponts et Chaussées* for May and June, 1853, appears to doubt the correctness of this conclusion, but even he admits that the preservative action of the lime depends upon its absorption of carbonic acid gas, and that directly its hardening ceases, it loses its power of resisting the action of the atmosphere on the iron.

M. Payen found that the addition of very small quantities of the sub-carbonate of potassa, or of sodium, to pure water, was sufficient to render it innocuous either to cast or wrought iron, and the same property existed in nearly all alkaline solutions; whilst, on the contrary, the addition of a small quantity of the chloride of sodium rendered the process of oxidation much more rapid than it usually is in pure water. It appears that grey cast iron is more susceptible of destruction by oxidation than

either wrought iron, or white cast iron; and that wrought iron resists the action of sea water more effectually than cast. It is a peculiar fact connected with this subject, that iron, exposed to frequent displacements, shocks, or vibrations, is less affected by oxidation than when it remains constantly in one place, without disturbance. Thus, anchors in constant use are less exposed to rust than those preserved in the magazine; the rails of the main-lines of railroads are less corroded than those in the sidings; iron steamers rust less when in active service than when in dock. But the positions in which iron decomposes with the greatest rapidity, are those where it is fixed, and alternately exposed to the air and immersed in sea water. Ammoniacal and sulphuric acid gas exercise very serious effects upon the durability of cast and wrought iron. It is important, therefore, to prevent their use, either in urinals, roofs over gas works, or the engine sheds of railway stations. There appears also to be some danger in using iron in contact with sulphate of lime, or in fact under any circumstances where it is likely to take up sulphuric acid gas, for which it has great affinity.

The galvanization of iron, which, as generally practised, consists in forming a superficial coating upon the metal by immersing it in melted zinc, appears to constitute an efficient protection, so long as the iron is covered. The contact with the zinc brings the iron into an electro-negative state, and it is known that, so long as the latter prevails, there is little tendency on the part of the iron to combine with oxygen. From a series of experiments made at Brest between the years 1842 and 1851, (see note by M. Dehargne, *Annales des Ponts et Chaussées*, 1851) it appears that the zincing process does not, in any sensible degree, affect the tenacity or the ductility of the iron; but it is important to secure the protected metal from any shocks, or friction, likely to remove the surface.

Zinc, when exposed to the atmosphere in its ordinary state, becomes rapidly covered by a whitish efflorescence, which adheres to the metal, and forms, as it were, a species of varnish, capable of arresting any further decay. This efflorescence is considered to be a carbonate of zinc; but if the atmosphere should contain any sulphuric or hydro-chloric acid, (as in London and in the immediate neighbourhood of the sea,) compounds are formed of a nature to compromise the solidity of the metal. In the purer atmosphere of Paris, and other continental towns, where wood is the ordinary fuel, and to which the sea air does not reach, zinc is employed successfully for roofing purposes; in London, and on the sea shore, its durability is very limited; and at all times its combustibility must be a serious objection to its use externally, especially for roofs.

Copper resists the action of the atmosphere very successfully, and the presence of some of the gases mentioned above does not seem to affect it in any material degree. A film of oxide, or carbonate of copper, is rapidly formed over the surface, and secures the metal from further decay. It is found, however, that a mixed metal or bronze, made of copper and zinc, resists the influence of the atmosphere, and sea water, more successfully than pure copper alone.

Lead undergoes little change upon exposure either to air or water, especially when the latter contains small proportions of the salts of lime. According to Brande, when lead is kept in distilled water, to which air has access, small crystalline scales of oxide of lead are formed, a portion of which dissolves in the water, and is again slowly precipitated in the form of a carbonate. Soft water also, or that without the salts of lime, appears to be more likely to attack lead than that containing lime. The use of lead for cisterns must, therefore, be regulated by the nature of the water to be preserved in them; for all roofing or analagous purposes, there do not appear to exist any philosophical reasons to object to the use of this metal, or to limit its application to any particular districts.

A very important remark with respect to the use of metals must be made: viz., that when

two of them are used in contact in positions where moisture, in any form, has access to them, a species of galvanic action is established, which causes them to decay with great rapidity. Illustrations of this may be observed in iron railings, when the bars are secured to the stone curb with lead, and the decay is most evident when the iron is of the best and most malleable description. A similar phenomenon may also be observed when copper, or bronze, is in contact with iron in sea water; though the iron decays rapidly, it appears to exercise a protective influence upon the copper.

The laws of electricity developed by the contact of two metals with a liquid containing a solution of an alkaline salt, are treated at some length in vol. 1, Gmelin's *Hand-book of Chemistry*, p. 364. From this authority it appears that zinc, tin, and iron, protect copper in sea water. Zinc protects iron and tin plate, but it is not so effective for the defence of iron in sea water if air be present, and it is itself rapidly corroded when used with iron in the sea. In that element tinned iron decays unequally, the iron oxidating whilst the tin remains intact; and it appears that the decay, superinduced by the contact with tin, is greater than that resulting from the contact with copper. The corrosion of copper may be considerably retarded by fastening to it at several points pieces of cast or wrought iron, or of zinc, when sulphuretted hydrogen is likely to be present. Water containing bicarbonate of lime will deposit the lime if placed in contact with zinc and copper, the deposit taking place upon the copper; and when water of this description flows through leaden pipes, the carbonate of lime is deposited at the solder joints (composed of an alloy of tin and lead), on the brass cocks, and on any piece of iron or silver which may be introduced. The inconvenience arising from the stoppage thus produced may be obviated by the use of a lateral pipe fitted to the main at intervals, and furnished with plugs of a metal likely to deposit the calcareous matter, which can thus be withdrawn from the main.

The class of atmospheric influences included under the term medial action in the early part of this paper acts more powerfully upon some of the metals than on other building materials. Thus the tenacity of the former increases or diminishes with the temperature, and the electrical state of the atmosphere frequently modifies their powers of resistance. The most elaborate observations which have been made on this subject have been exclusively connected with the changes superinduced in iron, perhaps on account of its more general employment. They are to be found in Mr. Fairbairn's *Treatise on the Application of Cast and Wrought Iron*, and in a communication by M. Wertheim to the *Annales de Chimie et Physique* (3rd series, vol. 12) from both of which it appears that the coefficient of resistance of the metal diminishes with an increase of temperature in a more rapid proportion than the dilatation. Below and near the freezing point cast iron becomes exceedingly brittle, but between about 40° and about 120°. Fahrenheit there does not appear to be much change in its elastic powers. The lineal dilatation of metals, and indeed of all building materials, requires to be carefully attended to in all constructions. Very useful tables upon the subject are to be found in *Weale's Engineers' and Contractors' Pocket-book for 1854*, and in the *Annuaire du Bureau des Longitudes*.

Glass under certain circumstances is affected by the action of the atmosphere, for the potash and soda employed in its manufacture are susceptible of being decomposed and removed by the moisture, or the gases contained in it; and according to Gmelin the decomposition takes place with greater ease in proportion as the glass is richer in the above-named alkalis, and the temperature of the moisture or water is higher. Glass in which there is a deficiency of silica is exposed to this description of decay, which may often be distinctly perceived in window glass, the alkali from which is gradually attracted (Knapp's *Applied Chemistry*, vol. 2, p. 8) by atmospheric moisture and washed away, whilst a thin layer of silica or silicate of lime remains upon the surface and

exhibits a play of prismatic colours. An analagous decomposition takes place in the glass used in stables in consequence of the ammoniacal gases ; and, according to Knapp, glass containing oxide of lead is liable to blacken on exposure to air impregnated with sulphuretted hydrogen.

The chemical changes produced in oleaginous and metallic pigments by the gases contained in the atmosphere are subjects of the highest importance to the decorative artist, but as the examination of them would extend this paper too far beyond the usual limits, I must refer the architect who would investigate them to the researches of M. Chevreul in the *Memoires de l'Académie des Sciences*, 1850 (vol. 22). I may, however, state that M. Chevreul attributes the solidification of paints to the oils they contain absorbing oxygen from the atmosphere, and states that the driers act by facilitating the power of absorption. The various substances introduced to communicate colour appear to affect the rate of absorption ; and the surfaces upon which the paints are applied have an influence independant of their mere capacity of taking up moisture. The varieties in the rates of drying upon the several woods and metals, experimented upon by M. Chevreul, indicate some peculiar differences in this respect, which have not hitherto been sufficiently examined.

The consideration of the numerous topics of interest contained in Mr. Burnell's paper was deferred to another opportunity, and the thanks of the meeting having been presented to that gentleman, the members adjourned.

OMISSIONS IN THE DISCUSSION OF MAY 15th, 1854.

The CHAIRMAN asked Mr. Morewood, what would be the cost of the two tunnel sewers carrying off not only the ordinary sewage water, 70 millions of gallons daily, but 270 millions. Mr. Morewood replied, that the contract was ready to be taken at one million sterling. He also said, that the Metropolitan and City Commissioners of Sewers had added to the two tunnels several high level sewers for storm waters, involving an extra cost of two millions sterling, and hence declared that three millions were required for "main drainage." In opposition to this, he stated that the surveyor to the City Commission had himself told him twelve months ago, that the two tunnel sewers as proposed, would carry off every thing except on twelve or thirteen days, during which storm waters would pass through the present channels into the Thames.

Mr. Morewood having also stated that Sir William Cubitt had given in evidence: "Three quarters of an inch of rain fell yesterday, and we saw nothing of it; in twelve hours there was nothing seen of it, it made no disturbance at all,"—urged that a rainfall of 23 to 27 inches, during 150 or 190 days, did not admit of a frequent fall of $\frac{3}{4}$ of an inch, and that a still greater fall was extremely rare and partial. Under these circumstances he expressed his astonishment that the Commissioners of Sewers had proposed to spend two millions for such high level sewers, to provide for storm waters. He declared that the intercepting sewers to pass in the bank of the Thames formerly suggested were impracticable, as the levels would not admit of their discharging the sewage.

In answer to the objection that the Metropolis should not depend upon an artificial removal of sewage water; he stated that the water daily converted into sewage, was artificially supplied, and when steam engines ceased to be able to pump up the sewage in the marshes, east of London, they would also cease to supply the inhabitants with water; a high level sewer costing £500,000. would only save an annual expense of £4000. for pumping and would entail consequences which had been entirely overlooked.

The Great London Drainage Company's Bill proposed government controul, supervision and audit. The guarantee of a contingent 3 per cent. was only asked on one million sterling; £37,000. were deposited as security—impounding of money was suggested by the promoters, and also that the 3 per cent. should only be paid, provided the works were completed within a certain period.

ON ARCHITECTURE AS REPRESENTED IN PICTURES.

BY H. TWINING, ESQ.

Read at the Ordinary General Meeting of the Royal Institute of British Architects, June 12th, 1854.

CONSIDERING the extensive field for enquiry presented by the subject of my communication, I should feel much diffidence in introducing it, did I not in a great measure rely upon the observations, which your superior knowledge of architecture will enable you to make on those points which my paper may suggest, and thus impart to it a degree of interest and usefulness which might otherwise be wanting.

In the first place, pictures exhibit in a convenient manner for study, the different styles of architecture in direct connection with different kinds of scenery. (This point was illustrated by engravings of Indian edifices by Daniell). As we are thus enabled to appreciate the relation of architectural buildings to the climate and character of different countries, we have great facility in selecting those styles or orders of architecture which are best adapted to the scenery, as well as the climate and conditions of our own country. Moreover the architecture which adorns pictures is exempt from those trammels which considerations of economy and site, and other hindrances, impose on the work of the architect; and it therefore possesses every facility and advantage for realising the kind of edifice which, in the mind of the artist, appears most consistent and becoming.

As the kind of embellishment which architecture supplies for historical pictures was more resorted to formerly, than at the present time, it is by considering the old masters that interesting facts may be chiefly elicited. One of the most striking points in connection with this subject is, that architecture seems to have been generally treated by them as a somewhat conventional ornament, adapted to the effect of the picture, but without reference either to the country, or to the period of the event represented. The style of architecture most usually selected was the classic, which is frequently brought into connection with events taken from the Scriptures, and which therefore occurred chiefly in Judea. But notwithstanding the impropriety of introducing the classic style of architecture into subjects which are entirely Eastern, the association of the simpler orders of such architecture with scriptural subjects does not strike so offensively as might be expected, a proof, it may be considered, that this style is remarkable for its great purity, and for its suitableness for all dignified or elevated subjects.

It would be difficult to believe that the Saracenic, the Renaissance, or any other elaborate style of architecture, could by any contrivance be made to associate with events so solemn, and at the same time so decidedly local, as those which are borrowed from Scripture.

Raphael was one of the Italian masters who had most recourse to architecture for the embellishment of his pictures; and although he did not always avoid the inconsistencies and anachronisms which contemporary artists were apt to commit, he showed an attention to circumstantial facts and particulars which very few equalled. One of the earliest and most beautiful of his works, known as "The Marriage of the Virgin Mary," now in the gallery of Milan, is adorned by an elegant building of sixteen sides with Ionic columns, probably intended for a synagogue, but not having anything Eastern in its style. Its appearance has however nothing offensive, but affords a pleasing accessory to this beautiful subject. In his painting of "Paul and Barnabas at Lystra," this great artist has shown the same attention to circumstantial details, and with the happiest results; for amongst

the statues which decorate noble edifices, the statue of Mercury appears conspicuous, reminding the observer, at once, that the inhabitants believed St. Paul himself to be that God; and that they were about to offer sacrifice to him as such; it is plain how much the historical account is elucidated by such particulars. "St. Paul preaching at the Areopagus at Athens," likewise affords a successful proof how much Raphael enhanced the beauty of his historical pictures by means of tasteful architectural buildings, of which the classic orders, clearly defined, are perfectly and appropriately characteristic. In another picture (of which the cartoon is at Hampton Court) representing St. Peter and St. John healing the lame man at the gate of the temple which was called "Beautiful," he has introduced a number of spiral columns, richly and elaborately decorated; by which means he has marked impressively the characteristic splendour of the porch. But in this instance his attention to particulars does not appear to have been equally successful, for the effect is meretricious, and detracts from the solemnity of the subject. A simpler style of architecture, though perhaps less truthful, might have been better suited to the dignity of the composition.

Neither Michael Angelo nor Leonardo da Vinci, although the first was an architect, and the second an engineer, seems to have resorted much to architecture for the embellishment of their pictures. Nor did Correggio, who at Parma contributed so much by his frescoes to embellish the Duomo, avail himself of the beauties of architecture to enrich his most graceful subjects. The Venetian school of painting, however, borrowed a great deal from the sister art; and in this we may probably mark the influence of the architectural magnificence of the city.

Gentile Bellini was one of the earliest masters who painted architectural subjects; and during his residence at Constantinople he executed a large, and, at the same time, elaborate and highly finished picture of the church of Santa Sophia, which is now in the gallery of Milan.

Another picture of the Venetian school, very remarkable for its architectural interest, represents what was termed the "Miracle of the Ring," so famous in the Venetian annals. It was painted by Paris Bordone, and the back-ground represents the beautiful and highly decorative architecture of the Palazzo Ducale almost as it now stands. But the artist of this school who gave the greatest importance to architectural ornament in his pictures was Paul Veronese. By the introduction of architectural monuments on a large scale he imparted great beauty and originality to his pictures. He often gave perspective depth and greatness to his compositions by representing these edifices at various distances. Further, by placing them on the most diversified situations he added in a remarkable degree to their picturesqueness. These architectural arrangements afforded him the means of diversifying the positions and attitudes of his figures, which he represented alternately ascending flights of steps, leaning over elevated balconies, or climbing up buildings, in order to overlook the principal scene of action.

The Dutch and Flemish, as well as the French painters, usually showed the same disregard for a style of architecture in accordance with Eastern subjects, as did the Italians. For instance, Rubens, notwithstanding his extensive information, and his high position in society, introduced the Doric order of architecture in connection with "The Murder of the Innocents." Nicholas Poussin, who largely availed himself of the advantages afforded by architecture, introduced columns, apparently of the Corinthian or Ionic orders, in paintings of David and Goliath. "The Murder of the Innocents" by Le Brun, now in the gallery at Dulwich, is likewise enriched by edifices of Roman structure, having columns of the Corinthian order. We might have expected rather more antiquarian knowledge or attention to facts, from so eminent and comparatively modern an artist.

But it is especially as an embellishment to the landscape that architecture attains the highest value, and often ennobles scenes which without such ornaments would appear tame or trivial.

Among the landscape painters, Claude de Lorraine availed himself most effectually of the resources which architectural subjects afford; and by the frequent introduction of temples, arcades, palaces, and other buildings, into his landscapes, he imparted to them an elegance, and an air of classic dignity, which it would perhaps have been impossible to attain without the elevating influence of this class of accessories.

The two Poussins were especially fond of that kind of embellishment which is furnished by architecture; and Gaspar Poussin, who was essentially a landscape painter, added by such means greatly to the interest and character of his landscapes. For instance, he marked the strength of any lofty situation by walls and fortifications; the particular aptitude of any site for being inhabited by a large and populous city; and the loneliness of a retired spot by tombs, obelisks, and mausoleums. He thus stamped more impressively the local character of each subject.

The Dutch landscape painters; as Poelenburgh, Berghem, and Louthburgh, introduced buildings and monuments chiefly as ruins, in which forlorn, but venerable condition, these greatly enhanced their small pictures. But there is a class of artists, who instead of making architectural buildings serve as an ornament to their landscapes, completely spoilt their compositions by great abuse of the resources which it affords. Amongst these may be mentioned, Marco Ricci, Lingelbach, and sometimes Panini. They availed themselves of their sojourn in Rome to copy the numerous monuments of various periods which there abound. This they did, however, without taste and discernment; and in their pictures they introduced promiscuously, and in the greatest confusion, monuments of different periods, of different styles of architecture, indeed of the most opposite character, accumulating these incongruous elements with a confused profusion of which Rome itself does not afford an example. In some instances they rendered this heterogeneous assemblage more ludicrous by intermingling figures of different dates and costumes with the ruins.

Modern landscape painters have devoted themselves more exclusively to nature herself, and have availed themselves generally in a less degree of such means of embellishment as architectural buildings afford. However the French marine artist of the last century, Joseph Vernet, frequently introduced architectural buildings, especially light-houses, bridges, and aqueducts, with great taste and effect; and his English contemporary Wilson realised corresponding advantages by the ruins of such monuments. I need not remark that the late Turner, when not led by the fascinations of colour to neglect the resources of ornamental form, availed himself most advantageously of the decorative beauty of architecture in his landscapes, as may be seen by the grace and elegance which his picture representing "The building of Carthage" derives from its architectural monuments. We are aware that John Martin so completely commanded the resources of architecture that he thereby imparted a character of combined splendour and vastness to his compositions. In some of his pictures ancient cities surprise the observer by their extent, their remarkable situation, and the originality of the buildings. In others, as in "The Feast of Belshazzar," it is the magnitude of the palaces, and other edifices, which causes our admiration. In these subjects a style of architecture has been adopted, which though to some extent ideal, at least carries the mind at once to the time and the place of the event recorded, an attempt which had not been made by the landscape painters of olden times; and which, although till lately quite new in this branch of art, Martin carried out with the most complete success.

Mr. DONALDSON, Hon. Sec. For. Cor., considered that the painters who had introduced architectural subjects into their pictures might be divided into two classes : the first were real painters of buildings, such as Canaletto and Panini; the others, as Raphael, treated architecture merely in the light of an accessory, and to give contrast, by the repose of the structural masses, to the violent action and bustle of the figures. The Venetian School afforded good examples of the second class. It was obvious that though Raphael had exercised great thought and discretion in such accessories, he had committed some incongruities, as in representing strictly Roman architecture in buildings forming the background of the cartoon of St. Paul preaching at Athens. The introduction of architectural subjects into pictures might naturally have taken place in a city like Rome, abounding in ancient remains, which would work on the imagination of the great men composing the brotherhood of practitioners in art which existed there in the fifteenth century. Michael Angelo was an architect by accident—painting and sculpture were more especially his forte,—and his particular case, Mr. Donaldson would adduce as a reason why he entirely disagreed with Mr. Ruskin as to painter architects alone deserving the palm of excellence; Palladio, Sanmichele, and Brunelleschi, on the contrary, were highly successful as architects,—great play of contrasts was exhibited in their works—but they were not painters. The Beautiful Gate of the Temple shewn in one of the cartoons, might perhaps have been more correctly shewn with columns of Egyptian character, but it might be supposed that Raphael was himself ignorant of the real architecture of the place which he had undertaken to represent. Claude, on the contrary, introduced subjects taken from Italian ruins, finely grouped, and with great propriety, into his landscapes, and his example had been followed by our countryman Turner, who, by desiring to have one of his pictures hung between two by Claude, in the National Gallery, had evidently implied the estimate on which he set his own painting; and yet it should be remembered that Turner had accomplished no more than Claude had between 200 and 300 years previously, without any predecessor to instruct him, from whose productions he could obtain hints, and learn to avoid errors. To Claude, innate taste and the study of nature had alone been assistants. The value to a painter of having seen and studied the antient remains in Italy might be seen in the productions of Wilson the landscape painter. The training necessary to render an artist a good scene painter, in respect to treating architectural subjects with strict correctness, had produced good landscape painters in the persons of Stanfield and Roberts. The views of Daniell on the walls afforded a great lesson in the happy manner in which Indian architecture was composed and grouped to harmonize in all respects with nature—the deep shady verandahs and colonnades, surrounded by groves, and enlivened by cool fountains and glittering minarets, vieing, as it were, with the beauty of the Eastern climate. Mr. Donaldson felt that the Meeting were highly indebted to Mr. Twining for calling their attention to so interesting a subject.

The Rev. R. BURGESS, Hon. Mem., offered some remarks on the anachronisms observable, not only in the architectural accessories, but also in the dress and character represented in paintings in Italy, even in those of a late period. The ancient masters were no doubt ignorant of the architecture of foreign countries; still there would appear to be something arbitrary in these anachronisms, for which it was difficult to assign any good reason. In this respect modern painters had great advantages; modern discoveries have brought to light the knowledge of Assyrian art for instance, with which the ancient masters were totally unacquainted. Modern painters, then, should imitate the beauties generally, and not the ignorance of the latter, in these matters.

Mr. DONALDSON mentioned the fact of Garrick having performed the part of Macbeth in the costume of his own time: and Mr. SCOLES, Hon. Sec., said that Northcote had excused himself for instructing his pupil to copy armour of the time of the Commonwealth in a painting representing a classic subject,

by saying, it is better to copy what we can paint well, than to attempt what we do not know. Turner's skill in introducing architectural subjects into his pictures might arise from the knowledge he had obtained in the office of an architect (the late Mr. Bonomi), where he was in fact employed to put in back ground to the drawings. The architecture introduced in the cartoon representing the Beautiful Gate of the Temple, might not be so erroneous as had been supposed, as it should be remembered that Jerusalem, at the time represented, had been for years under Roman dominion, and that the gate in question was probably a comparatively recent construction.

Mr. PAPWORTH, Fellow, had the impression that Raphael was said to have represented the Beautiful Gate in conformity with a tradition concerning its structure. Some of the most effective compositions of architectural subjects in pictures had been produced by artists who were strictly scene painters, such as Bibiena, the Quadratisti, and Servandoni, celebrated for his designs for fêtes,—while even architects, as Novosielski, Soane, and Smirke, had furnished designs for scenic decorations,—Turner, in early life, had made numerous accurate drawings for architectural and topographical publications.

Mr. C. H. SMITH, Visitor, said that though the great masters had committed such anachronisms in buildings and costumes, men of less note were often free from such faults. James Barry, in his painting of the Olympic Victors, on the walls of the Society of Arts in the Adelphi, had correctly represented a Greek temple, and the peculiar Greek head dress, before the publication of Stuart's work on Athens, and the acquisition by the government of the Elgin marbles had given accurate information on these points. Unfortunately, painters were apt to neglect the rules of perspective, and hence they could not grapple with architectural drawing. From this stricture he must, however, except the accomplished painter of the picture known as Byron's Dream, in which the celebrated temple at Egina was correctly and happily introduced.

Mr. F. C. PENROSE, V.P., Chairman, with respect to the anachronisms of the old masters, thought that they did not strain their imagination to produce representations of objects which were of necessity uncertain and beyond their reach. All the knowledge we possess should be brought to bear on the subject, but in the present day, entering into too much detail caused artists to lose sight of the main object by overscrupulous attempts at accessories, as might be seen in some paintings in the exhibition of the Royal Academy. Architecture had suffered from the incursions of painters, and it should be remembered, in opposition to the dictum of a modern writer, that some of the most eminent architects of the revival—as Sanmichele, Bramante, Brunelleschi, and Palladio, were *not* painters. The beauty of Claude's architectural subjects was generally acknowledged, and the book bearing his name, called the *Liber Veritatis*, contained numerous excellent *motivi* connected with the subject of such accessories in landscape painting. For painting, generally, classic architecture would seem to be best adapted, its broad masses and repose telling well in contrast with the movement of the figures. At the same time it should not be forgotten that a most perfect specimen of the good effect produced by Gothic architecture, as an accessory, was to be seen in a painting by Van Eyk, in the Dresden Gallery, and that Raphael, in his early paintings, and his master, Perugino, introduced distant views of what might be called imaginative Gothic towers and spires. Mr. Penrose concluded by conveying the thanks of the Meeting to Mr. Twining, and the Members adjourned.

ON THE TOPOGRAPHY AND ANTIQUITIES OF CONSTANTINOPLE.

By the REV. R. BURGESS, B.D., Honorary Member.

Read at the Ordinary General Meeting of the Royal Institute of British Architects, June 26th, 1854.

I HAVE some doubts as to the success of this experiment which I am about to make upon the patience and intelligence of this Institute. Through a succession of seasons I have been indulged with a hearing once a year, and the scene of my antiquarian excursions has hitherto been limited to the ancient Metropolis of the Western Empire. Events which occupy the mind of Europe, rather than any particular wish of our own, have transported us to the shores of the Bosphorus, and perched us, in spite of ourselves, upon the heights of Scutari. But in launching forth from the Tiber to the untried waters of the Bosphorus, I do not navigate without chart and compass, nor am I about to describe a city I have never seen. It was my lot in 1834 to cast anchor in the Perami, and wander for some days about the Bosphorus and the Euxine Sea. It is the result of my poor researches into the Topography and Antiquities of Constantinople that I propose to give you this evening. I shall endeavour to make my paper consistent with the requirements of these conversazioni. I must bear in mind that I read a paper at the Royal Institute of British Architects, who, though not averse to an occasional reference to the modern city, will naturally look for the vestiges of those works which were made under the Greek Emperors before the Arts declined, and ere Classic Architecture fell before Mosques and Minarets,—we must begin with a page of ancient story.

658 years B. C. the navigator Byzas, said to be the son of Neptune, arrived at the Eastern promontory of Europe, and there he founded the celebrated city which was called after his own name, Byzantium; its first inhabitants were probably not much better than the followers of Romulus. They seem to have been the Bashi Bazouks of those early days, which we may freely translate to signify plundering rascals. The situation of this city was admirably selected, and it enabled the Byzantines to check the kings of Bithynia, and to fight with success against Philip of Macedon, and to stem for awhile the inundations of the Gauls when they rushed into the centre of Asia Minor. Pausanias, the Spartan General, after the defeat of Xerxes, fortified the place, and I shall shortly point out the limited space which was occupied by the original city. The advantageous position of Byzantium was soon discerned by the Roman Emperors. It is thought that Augustus conceived the idea of transferring the seat of Government to the Bosphorus, and not improbably the splendid Ode, Lib. iii. Ode 3, which proclaims the vengeance of Juno upon the attempt, was written by Horace with the view of deterring the Emperor from the audacious enterprize. 300 years elapsed, and then Diocletian revived the idea of fixing the seat of Empire nearer to Asia. The first Christian Emperor determined to carry the plan into effect, and he drew the line of his fortifications within sight of the scene of his good fortune. It was at Chrysopolis (now Scutari) where he gained his final victory over his rival for Empire, which made him the undisputed master of the Roman World. When Constantine began to build the city which still bears his name, he found an ample supply of materials within a few hours reach. The forests of the Black Sea furnished him with wood, the neighbouring island of Proconnesus afforded abundance of marble, the cities of Greece and Asia gave up the works of Phidias, Lysippus, and Praxatiles, and even Rome contributed of its stores of art to embellish the new capital; it was finished and dedicated in 334. 150 years after, during the reign of Arcadius and Honorius, who divided the Empire between them, a catalogue was made of all the public buildings in each quarter, like the regionaries of Victor and Rufus at Rome. This document is extant, and is known under the title of the "Notitia;" the author is unknown. It was first published by Guido Panciroli, and it

helped Gyllius to find his way in the comparative Topography of the two capitals of the Roman Empire. But Constantinople received a considerable addition to its extent under Theodosius II., 413, as I shall have occasion to point out when we come to make the circuit. Another portion added by Heraclius in 620, must also be taken into account before we get the whole of what is now enclosed by the triple wall of Stamboul. The lively waters of the Bosphorus, after rushing out of the Euxine Sea and flowing in a winding channel for 20 miles, break against a triangular shaped promontory, which forms the Eastern extremity of Europe. They are then parted into the Propontis and the Canal of Perami, which forms the magnificent harbour of Stamboul. The ancients compared this canal, with its winding branches, to a stag's horn, and it is called by Strabo the Horn of the Byzantines; but the antlers are now broken off. It is capable of containing 1,200 ships of the largest size. On the side of the Horn opposite to Galata rise the mosques and habitations of Constantinople. The city is a triangular figure, about 13 miles in perimeter, along a shore extending from East to North to a distance of 3 miles, forming *one* side of the triangle. There were anciently twelve gates which opened upon the Port, most of them still remain in their original sites, and retain their ancient names in the present Turkish designations,—the one at the Seraglio Point, called the Porta Eugenii, (*a*)—another, nearly opposite St. Sophia, called Porta Neoria, or Naval Gate (*b*), and now in Turkish, Tchifout Capoussi, are no longer in use. It was from the Porta Navalis that the chain was suspended which (drawn across to what is now Galata) shut up the entrance into the Golden Horn. I have in former times fought so many battles over the Gates of Romulus, which, after all, may never have existed, that I should feel reluctant to engage either you or myself in a controversy about the names of the Gates of Constantine, particularly as we should have not only to cope with various readings of Greek, but to adjust the value of a Turkish translation. To proceed with our Gates.—No. 1. Ghemi Iskelè, or the Fruit Gate, called also Zindan Capoussi; it was anciently called the *πύλη των καραβίων*, or Gate of Boats, and it is at this time the principal landing place for the caiques crossing the port from Pera. No. 2. Oun Kapaneu Capoussi, anciently the Porta Farinaria, the gate by which the corn was taken into the city; it is now closed. No. 3. Djubali Capoussi, or the Glazier's Gate. I cannot find an ancient name for this. No. 4. Aia Capoussi, that is *πύλη αγια*, the Holy Gate, so called because the people landed there to go to the Church of S. Theodosia; and it is remarkable that the Turks should have annexed the Greek adjective *αια*, or *αγια*, holy, to their Turkish substantive of Capoussi. We come now to the Fanar, which is the quarter of the city that has been inhabited by the Greek princes and nobles ever since the fall of the Greek Empire. The heroes, descendants of the Cantecuzene and Palæologi, who went forth to fight for freedom in 1820, were principally Fanariotes. The Fanar Gate is still called by the Turks, No. 5. Petri Capoussi, or the Gate of Peter. Indeed the whole district was named after the Apostle of the circumcision. The Regio Petri is celebrated in the siege of Constantinople, 1453. When Mahmoud II. had transported his light ships overland from the Bosphorus, not being able to force the chain drawn across from the Porta Neoria, he launched his boats nearly opposite the Gate of Peter. Notaras defended the gate with great valour, but his abject submission to the conqueror afterwards, tarnished his renown. If he had had a single screw steamer, the multitude of light ships which had been carried over the heights of Pera had never shaken the Gate of the Fanar. This gate, like all the rest on the port, is narrow and low, a mere opening in the curtain of the wall; just within it stands the house of the Greek Patriarch, and the Patriarchal Church of St. George, to which we shall again recur. No. 6 is the Gate which leads to the Jews' quarter, called Balat, which in all probability is a corruption of Palatium, for the gate formerly was the *βασιλική πύλη*, or Royal Gate, leading to an imperial residence, of which there are some remains. No. 7 is Haivan Hissari, anciently called Cynegeton, or the Gate of the Vivarium, the place where wild beasts were kept for the use of the amphitheatre, which was situated at this extremity of the city. The Chiloporta (*c*) at the very angle of the city is closed. Before

leaving the enclosure of the Balat, we have the Egre Capoussi (No. 8), anciently called Charsias. Towering above the city walls we see the structure of a building which is called the Palace of Constantine, but ought rather to be called the Palace of Heraclius, for we are now in that portion of the city which was added by that Emperor in 620. From hence we strike across the Continent to pursue the line of walls which stretch from the Perami Canal to the Sea of Marmora, a length of about 4 miles, and forming the base of the triangle or harp, to which may be likened the form of Stamboul. No. 9. The Edrene Capoussi, or Hadrianople Gate, anciently Poliandron, may be considered as the first that occurs in the walls of Theodosius. A few words of general description will be in place here.

These walls present a triple line, and have retained, in a great measure, their original appearance. The inner wall is the highest of the three ranges, and it is strengthened by lofty towers, indifferently square, circular, or octagonal. The second or middle wall is much lower, and the towers less, being generally circular; and the third, or outer wall, with batteries running along the top, serves as the barrier of the ditch or foss that runs before it. "The intervals between those walls are 18 feet wide, and are in many places choked up with earth and masses of fallen ramparts." The materials are almost invariably stone and brick, in alternate courses. The towers in some parts are completely clad with ivy, in others half ruined and half overshadowed by the fig-tree, which has caused the rent, "*mala robora ficus*." The solitude beneath those ramparts is as complete as it is in the vicinity of the walls of Rome, and it is saddened by the melancholy groves of cypress trees which stand over the Mussulmans' graves. Passing the Edrena Capoussi, we must stop for a few moments at the next, No. 10. It was called S. Romanus, the Turks now call it Top Capoussi, or the Cannon Gate, on account of the great event which took place in 1453. It was here that the last of the Constantines bravely fought and fell before the everpowering force of Mahmoud II.; his body was found after some days under heaps of slain, and was only recognised by the silver eagles upon his slippers;—if ever

The city won for Allah from the Giaour,

The Giaour from Othman's race again may wrest,

the great struggle will be at the Top Capoussi: there the assailants would be beyond the reach of war vessels in the ports, and the heights of Scutari are too distant to afford protection: in short, the whole line of wall, from the Blachernæ to the 7 towers, would require to be covered, if 50,000 Russians should ever cross the Balkan. A little further, and we arrive at the Mevlanè Yeni Gate, No. 11, called in former times Melandisia. It bears upon the long lintel, which rests upon two consols, a Greek inscription, and the following in Latin:—

Theodosi jussis gemino nec mense peracto

Constantinus ovans hæc mænia forma locavit

Tam cito tam stabilem Pallus vix conderet arcem.

No. 12 and 13 are respectively the Selivri and the Kapaneu Gate, anciently the Porta Quintii, and the Porta Attali. We now arrive at the enclosure which surrounds the Golden Gate, and the Yedi Kouleler, No. 14, or Seven Towers. Considering the Seraglio Point, where the Sublime Porte exists, to be the seat of government, we are now at the farthest extremity of the city. Behind the trees which hang from the walls, and flanked by two large square marble towers, is discerned the Porta Aurea, or Golden Gate; this was in fact a triumphal arch built by Theodosius, to commemorate his defeat of Maximus. Compared with similar monuments at Rome, there is nothing remarkable in it for richness of ornament, or elegance of construction: on the top of it stood a statue of Theodosius, which, after being thrown down by an earthquake, was replaced by a statue of victory. The inscription upon it, which is still legible, is this—

Hæc loca Theodosius decorat post fata tyranni

Aurea sæcla gerit qui portam construet auro.

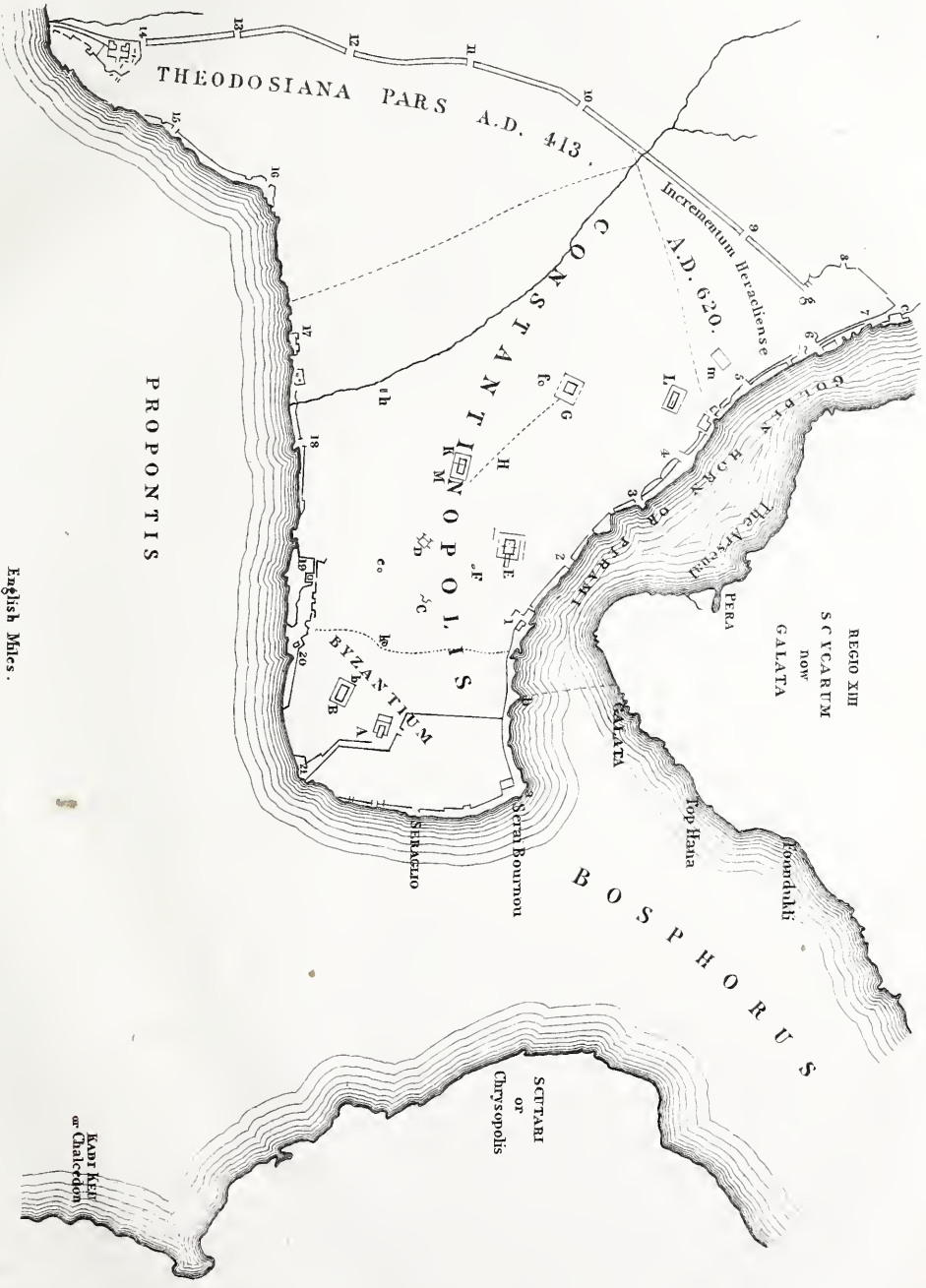
In the time of the Greek Emperors, there was a fortress at this extremity of the walls, it was called Cyclobion. The Latin armies, who attacked Constantinople by the golden gate, destroyed it. John Cantacuzene rebuilt it, but it was in ruins when Bajāzet threatened the city. Mahomet II., the Conqueror of Constantinople, finally rebuilt the fortress on the same site, and added several towers. The Greeks called them Heptapirghion. The Turks, Yedi Kouleler, the seven towers. I could only discern four rising conspicuously above the outer walls of the city; in one of those, that nearest the Golden Gate, the foreign ambassadors used to be stowed whenever they displeased the Sultans. The times are changed, and perhaps the Sultans might find a lodging in the same tower, if they chance to displease the foreign ambassadors. This may be called the Bastile of Constantinople. It was within these gloomy walls that Brancovan, Prince of Wallachia, with his wife and four sons, were put to death; while Demetrius Cantemir, who had betrayed the unfortunate Prince, was satiated with the favours of Sultan Achmet. During the French wars, a Russian ambassador, Count de Bucalof, was imprisoned here for nearly two years; also a French ambassador, Rufin, who was severely treated. Even as late as half a century ago, Sir John Arbuthnot was threatened with a lodging in the 7 towers. There might be no objection perhaps to grant a lodging there now to a Russian ambassador. But at present, the successor of Baraguay d'Hilliers and Lord Stratford de Redcliffe, may look at the Yedi Kouleler with as little apprehension as I did on the last day of July, 1834. We have now to run along the third side of the triangle, which extends from the 7 towers to the seraglio, and is washed by the waters of the Propontis. The first gate that occurs is the Gate of the Bombshells, Narleu Kapou (15). The second retains its Greek appellation, Psamatia (16), or the Sandgate, and it gives the name to the quarter of the city to which it immediately leads, in which there is a considerable population of Greeks and Armenians. It contains churches, dedicated to St. Nicolas, St. Polycarp, and St. Basilus: it is probable that St. Nicolas is the least popular at this moment! The walls now recede from the line of shore, and form an angle at the Gate of Daoud Pascha (17), probably the ancient port of S. Emilianus. From here begins a valley which runs across to the Perami, and divides the city of Constantine from that of Theodosius. It is a thinly inhabited quarter, with a towering mosque. Gardens, not warehouses, occupy much of the space, and the whole has the appearance of a Turkish village. The next, that is the fourth gate on this side, is Yeni Capoussi (18), or Newgate. We next arrive at Koum Capoussi (19), another Sandgate; and from here to the Seraglio we obtain in our circuit, glimpses of the original work of Constantine; patched by Genoese, and Venetian construction,—towers built upon rows of columns inserted lengthways, and fragments of marble starting out of crumbling heaps in admired disorder,—this portion of the line of wall which ends at the Tehatladi Capoussi (20), is a faithful representative of the Turkish Empire. Like these walls, it is built up of heterogeneous materials, and fragments kept together by cement got by foreign aid, capable of little resistance, and presenting a motley sort of construction of the Arabesque order. The last gate (21), Akhour Capoussi, or the Stable Gate, so called because it leads to the stables of the Harem, and from it begins the enclosure of the Seraglio. With these mysterious walls we round the promontory which forms the Eastern extremity of Europe, and represents the apex, somewhat flattened, of the triangle whose perimeter we have now measured. Bondelmonte reckons from the angle at Blackernes to the Golden Gate 180 towers; from these to the Cape S. Demetrius 110; and he makes the whole circuit of the walls 18 miles; but this must be meant to include Galata, on the other side of Perami,—a suburb of Constantinople we have yet to describe. In order to proceed with this, I must take you in a light caique from the Seraglio Point, Serai Bournou, across to Tophanè, and we arrive at Galata, to which must be added Pera. These two suburbs separated from the Stamboul of the Turks by the Perami canal or harbour, were possessed by a colony of Genoese. After the holy wars had ceased, at the end of the 13th century, they obtained the suburb as a fief from the elder Andronicus, and they surrounded and fortified it with walls. The Venetians attempted

to wrest it out of the hands of their rivals, but in 1352 the Genoese were victorious. They engrossed the commerce of the East for a century, and their wealth enabled them to overawe the enfeebled power of the Greek empire. They made a struggle against the formidable Mahmoud II., but were involved in the general ruin of Constantinople. The walls of their city have stood unto this day. They run from the artillery barracks of Tophanè, to the mariners, near Cassim Pacha, along the shore of the Perami; they ascend the hill in a zigzag line to the tower of Galata, and descend to the vicinity of the grand mosque of Mahmoud. They are built of small square stones, with numerous fragments of antiquity filling up the voids. The towers are round or square, as it happens, and it appears the colony was governed by a Podestà. I copied this inscription—*Spectabil Nobil Ilarius Imperialis Potas Pere*, but I know nothing more of this respectable noble Ilarius than this inscription. I found the dates 1433—1447 upon the towers, and it was only six years after the latter date that Constantinople was taken by the Turks. This district, now known as Galata, was anciently called the “Regio Sycarum,” or the fig trees: in the ancient “Notitia” it is registered as the XIII. Region; and it bears about the same relation to Constantinople proper, as the Trans-Tyberine Region at Rome bears to the seven-hilled city on the left bank of the Tyber. The emperor Honorius built a forum and theatre here, and there was a temple of Amphiarus, and another of Diana Lucifera. The emperor Justinian joined this region to the main city by a bridge thrown across the harbour, and he gave it the privileges of a municipality, with the name of Justinopolis; but the name is now only to be found in the pages of Procopius. A few broken columns employed in the Genoese houses, or lying in the corner of the streets, are all the vestiges that can be found of the ancient monuments. I need not bring you back to Galata and Pera, for, except the arsenal of Cassim Pacha, we should find few objects worthy of a Cicerone. We now embark again in our light caïque at Tophanè, and cross the Bosphorus to the port of Scutari, a distance of two miles. If we ascend to the top of Bourgaloue, we obtain a magnificent view of the cities we have already surveyed. We see into the gulf of Nicomedia, and the eye runs along the Western shore of the Bosphorus; the mountains of Asia appear to fall in azure folds; in the distance we look over the fields of Europe, and catch a view of the Propontis. Chalcedon, now Kadikeu, lies at the foot of the mountains, and the name of St. Euphemia preserves the remembrance of the famous council held in 451, when the heresy of Eutyches, to which the Armenians still adhere, was condemned; the founders of Chalcedon have become immortal in contempt, for having selected so ineligible a position for a city, when they had the promontory before them, on which Byas, with more discerning eye, founded his city thirty years after. But Kadikeu or Chalcedon still serves for our topography, for as the Bosphorus begins to expand its waters into the Propontis it passes between Byzantium and the ancient Chalcedon. From Kadikeu we may ascend to the vast cemetery of Scutari: this is a forest of cypresses, extending for several miles, and in the deep recesses of its gloom are interred the remains of pious Mussulmen of many generations. Every true follower of Mahomet prefers the country of the prophet for his last resting place,—he considers Asia, not Europe, his home,—he believes his mortal remains will be better protected from the profanation of the infidel: but perhaps none of the myriads which now sleep in the dust ever dreamt that some 25,000 Giaours or infidels would, in the year of Hegira 1270, be taking their pastime among the cypress groves of Scutari. This Asiatic suburb, although said to be as large and populous as Smyrna, has more the aspect of a village than a large town, except about the port. I speak of its ordinary appearance, it occupies the site of the ancient Chrysopolis, and was in the time of the Crusades covered with the armies of Godfrey de Boulogne. I have already said that it was upon those heights above the port where Constantine triumphed over the last of his rivals for empire the unfortunate Licinius was taken captive to adorn the triumph of the conqueror. The barracks which are, or have been occupied by the British troops, were originally built by Sultan Selim, and after being burnt in the Janissary war of 1832, were reconstructed as they now exist by the father of

the present Sultan. The gaiety which reigns around the open fields and barracks of Scutari, contrast strangely with the gloom of the sepulchres: life and death appear to go hand in hand. Under the shade of the cypress trees are groups of females in gay attire, resting against the painted turbans on the tombs, and squatting on the graves of their relations; the merry laugh goes round, and not a thought of gloom appears to cross their revelry. The Arlabats which jingle past are saluted from the tombs as gaily as from the balcony, and the grave which has not yet grown green is the scene of life among the dead. The most imposing tomb I saw was formed of a canopy resting on four columns, covering an ample space; it was the resting place of no distinguished warrior or statesman, but the tomb of Sultan Osman's favourite horse. The great sight at Scutari is the performance of the howling der-vishes, but the description of "this religious liberty" I leave to "our own correspondent." We now leave the Asiatic suburb of Constantinople, and for a general survey of the places I have so far described, I shall ask you to accompany me to the top of the Seraskier's tower (F). It stands within the enclosure of the old seraglio, and on the highest ground in Stamboul. From this advantageous position the spectator may trace the outlines of the seven hills on which the city of Constantine, like Rome, was built. The space occupied by those seven hills was divided into thirteen regions, the one on the opposite side of the canal made the fourteenth, although it was the thirteenth in numerical order. The XIV. regions were no doubt in imitation of the internal arrangements of Rome, made by Augustus: by the help of the Notitia, and by the measurements given in it, we may ascertain much of the topography of the ancient city.

THE SEVEN HILLS OF CONSTANTINOPLE.

The number seven is all the resemblance that exists between the hills of Rome and those of Constantinople, no renown hovers above the Byzantine topography, the hills have not even names, and glory has not left so much as her twilight to preserve them from oblivion; they may however be traced, and their outlines be as strongly drawn as the Esquilæ and Viminal, and the Quirinal of Rome, which is not saying much. A topographical survey of the city of the East, is not complete without them, but I shall do little more than point out to you their positions by citing the most conspicuous buildings which stand upon each. The first may be limited by the Seraglio walls, and comprises all the space on which St. Sophia and its appendages now stand (A); the second may be traced from the Mosque of Sultan Achmet (B), in a line towards the Osmaneæ (C); and the Bezestein, "the burnt pillar," to which we shall shortly return, stands on the most elevated part of it, and its outline may be followed towards the Propontes at the Tchatladi Capoussee (20); these two hills may be considered as comprising the site of the ancient Byzantium. The third hill is crowned by the splendid Solimaneæ (E) and its extensive dependencies; it comprises the ground on which stands the Mosque of Sultan Bajazet (D), including the Seraskier's Tower on which we are now supposed to be standing, and reaching to the Validè Han, falls away towards the port. The fourth hill begins with the Aqueduct of Valens, and comprising the ground which rises above the old quarters of the Janissaries, it ascends to Sultan Mahomet's Mosque (G), and turns by the south side of the Fanar into the valley west below the old Seraglio. The fifth hill is distinguished by Sultan Selim's Mosque (L), and comprises all the Fanar down to the Golden Horn. The sixth hill, if hill it may be called, includes about one-third of the entire space within the circuit of the walls, extending lengthways from below the Mosque of Sultan Mahomet to the seven towers. In the year 413 Theodosius enclosed this space, and thirty years after, when the wall had been thrown down by an earthquake, it was restored by the Præfect Cyrus, whose glory so far eclipsed that of Theodosius the younger, that the people proposed to change the name of that part of the city and call it Cyropolis. Theodosius became jealous of the restorer of the walls, and it is said put him within the strong walls of a monastery, after having caused him to be shorn, and there he died of grief. The remaining hill reaches beyond, and comprises the quarter of the



TOPOGRAPHY OF CONSTANTINOPLE.

Vincent Brooks Ltd. King St. Covent Garden

Blachernæ which was left without the walls of Theodosius. The Emperor Heraclius added this to the city, and so entitled it to be called seven-hilled. The most conspicuous object on this seventh hill is Meribos Sultana Djami. I have already remarked, that as there were seven hills, so were there also fourteen regiones; each contained a number of public buildings which are enumerated in the "Notitia," but little remains of any of them to tell the tale, or to give the antiquary the pleasure of disputing. Time, war, fire, and the destructive tendencies of the Turks, have effaced the monuments of former ages, and if we would enjoy the view from the Seraskier Tower, we must invoke the muse of history, rather than the sullen genius of antiquity. We are here on the theatre of the world's exploits. A narrow channel divides Asia from Europe, those two quarters of the world which until modern times had monopolized the human race, and those arts which adorn its existence; the very waters of the Bosphorus are immortalized by deeds consigned to the lasting page of history. Over it once passed the innumerable phalanxes of Darius, the ten thousand warriors of Xenophon, and the crusading hosts of the pious Godfrey; upon it the celebrated Doria destroyed three hostile fleets in a single battle. Beyond it rises the first city in Asia, Scutari, the ancient Chrysopolis; near it, keeping one of the portals of the Propontis, is Kadikeu or Chalcedon, the school of sacred learning, but the scene of religious disorder; around us at our feet are the hills we have just been tracing out, marked by some conspicuous object which tells us we are in the city of the Sultans; the gigantic Mosque of St. Sophia is not entirely despoiled of that reverence which belonged to it in the days of John Chrysostom. The eye runs over the magnificent port crowded with skiffs, and carrying a whole city of souls upon its buoyant waters. Opposite is Galata, the work of the Genoese, once the emporium of the world, and still distinguished by the colossal towers which defend it: the countless habitations continue as far as the view extends, up the Bosphorus and the Canal. On the south glitter, on the Sea of Marmora, the Isles of the Princes, Akalki, Antigone, and Proti, the alluring retreats of the idle and wealthy; and finally the horizon is bounded by the azure tops of 1,000 far-famed hills, amidst which, as a sovereign among his subjects, towers the lofty Olympus. We shall now descend into the streets of Constantinople, and see what the ravages of time and fire have left for the antiquary and the topographer, and what recompense we have under the Mahomedan regime for the loss of our Roman buildings. Constantinople under the reigns of Arcadius and Honorius (who divided the empire between them into East and West, A.D. 380), contained 4,388 houses, besides fourteen extensive palaces or mansions, it contained eight Thermæ or large bath establishments, two basilicas, two forums, two senate houses, two theatres, fifty-two porticoes, 153 private baths, twenty public swimming schools, the purple column, two other honorary columns, and one colossus, a mint, a capitol, four harbours, a circus, together with cisterns, nymphæa, and other objects necessary for a great city; thirteen Curators and sixty-five Vico-magistri had the care of the whole; and there were at that time only fourteen Churches. It will be seen from the above enumeration, that the City of the East bore no comparison to Imperial Rome, either in the splendour or quantity of public edifices. The Goths and Vandals spared more of Rome than the Turks have done of Constantinople, and the basilicas and museums supplied by Popes, have by far outshone in splendour and magnitude the mosques and Hanès of a line of Sultans. The Hippodrome (d) is the first object of antiquity that attracts our notice, and upon its now disfigured arena, "we are met by the shades of Justinian and Belisarius." The Turks call it by a name which denotes its original purpose, Atmeidan, or the place of horses. Septimus Severus first made a circus in the midst of the ancient Byzantium, modelled, no doubt, after the Circus Maximus at Rome, and this afterwards became the Hippodrome; the space which was the arena is yet clear of buildings. Three monuments of antiquity remain in their original positions—1. a half ruined pyramid of stone, which it appears from an inscription was covered with bronze by Constantine Porphyrogenitus. 2. The twisted column of the bronze serpents, and 3. an Egyptian obelisk: all these stand in a line, and I have little doubt they formed some of the ornaments of the Spina; there is a bas-relief on the

obelisk which I take to be a representation of the Spina; from the stone pyramid to the twisted column I measured forty-seven paces, to the obelisk twenty-two; the whole length of the Hippodrome I calculated at 1,000 feet, that is about half the length of the Circus Maximus at Rome. I need not stay to describe the Pyramid of Stones, it is a rude work and merits little observation, but the Twisted Column is one of the most interesting classical monuments in existence; no one ever doubted that this curious relic was brought from the Delphic temple, and was the consecrated offering of the Greeks after the glorious defeat of Xerxes. Gibbon dwells upon this relic with delight, and even his sceptical mind admits that it is genuine. It now stands about eleven feet above ground, three serpents' tails are twisted together into a column, their heads supported the golden tripod, which, of course, has disappeared. Mahmoud with a stroke of his battle-axe broke one of the serpents, and the other two heads have gone with the golden tripod. If this relic were still at Delphi, it might be doubtful, whether it should follow the destiny of the Elgin marbles; but our allies, the Turks, are little curious upon these classical subjects; they have long ago scratched Arabic characters upon the folds of this Delphic column, and in the hollow of the bronze they have amused themselves by inserting stones; under these circumstances, I would encourage the idea of enriching our national depository of antiquities with the Twisted Column, and I should imagine, that a piece of cannon being of equal weight with the bronze, would be considered an ample equivalent for a useless piece of antiquity. The Obelisk was set up in the reign of Theodosius, as it appears from inscriptions still legible on the lower plinth of the pedestal; it would occupy me some time if I were to attempt to describe and translate the bas-reliefs, and inscriptions, Greek and Latin, which are seen on the four faces of the Obelisk: I hope the task may be performed by some of our centurions during the vacancy at Constantinople. The four steeds of brass now glowing before St. Mark's at Venice, "their gilded collars glittering in the sun," were taken from this Hippodrome, and most probably stood over the Porta Pompæ, that is the gate by which the processions entered the arena, through the middle of the "Carceres." The factions of the blues and greens, which once shook the walls of this Hippodrome have long since ceased, but the scenes of cruelty and bloodshed of which this arena was the witness, inflicted such a wound on Oriental Christianity, that Mahomedanism had at last an easy victory. The Moslem has now enjoyed his triumph of a thousand years, his dusky wings have overspread the fairest regions of the East.

"While blasted by his crescent's dreadful glare,
The bloom of science and of genius dies!"

There were several triumphal columns in Constantinople, one in honor of Theodosius, which stood on the seventh or most remote hill, and on each side were the statues of Arcadius and Honorius; these are no longer existing, except in the pictures of Gentile Bellini; but near to the Avret Bazaar, there stands a pedestal sustaining the Torus of a column's base, and this was the pillar of Arcadius. Not far from the Shah Zadi Dgiami (M), or Mosque of the Sultan's Son, stands a column called by the Turks "Kistash," or the Virgin's stone (F); the basement and pedestal are of marble, the shaft of granite, and it has suffered by fire; on the upper plinth we can still decipher the three words, *Quod Tatianu sopus*: but the English traveller, Wheeler, read the whole inscription: it was erected to Tatian, by the Emperor Marcian, who ascended the Byzantine throne in 450: the capital is a ponderous weight of marble placed on a tall shaft, and it would require all the skill and knowledge of this Institute to explain the winged figures and the monograms which appear on the capital and the pedestal: such caprices generally mark a period of decline in art and genius, not unlike some authors, who, for want of originality, fill up their pages with inapt quotations, and try to conceal the theft. The Aqueduct of Valens is best seen near the At Bazaar, or horse market; its origin, no doubt, is Roman, but its conspicuous rows of arches are chiefly the patchwork of the Sultans. The next object of antiquity worthy of notice, is the Burnt Pillar, which has attracted the special notice of travellers (e),

it is of porphyry, the shaft composed of several pieces, the jointures concealed by garlands ; it is now bound in several places with iron bands to keep together the calcinated pieces loosened by the fire ; it is said to have been brought by Constantine from Rome, and on the top was a statue of Apollo ; on the upper part is an inscription bearing the name of Manuel Comnenus as the restorer. When Mahmoud II. entered Constantinople, the Greeks had a prophecy, that when the invaders arrived at the Burnt Pillar they would be stopt by the destroying angel ; but the prophecy did not come true. Pocock observes, that Arius died near this column ; very near to it are the subterraneous cisterns, two of them now dry, and only used for spinning silk and making ropes ; in one of them (h), I counted five divisions supported by thirty-two granite columns of perfect symmetry ; the second is said to have 1,001 columns, which is just the number of stories in the Arabian Nights Entertainment, but I did not take the trouble to verify the number. There is a third cistern which still serves the original purpose (k), it is called Batan Serai, and Gyllius counted in it 336 columns ; it best explains the nature and objects of those large works made by the Greek Emperors for supplying the city with fresh water ; they appear to have attracted the attention of our countrymen more than any other object of antiquity, and I can conceive a practical engineer, or even the commissariat, preferring the Cisterns to the Burnt Pillar or the Twisted Column. The rest of the antiquities of Constantinople must be sought for in the walls of Mosques and in the gardens of the inhabitants ; fragments of marble are frequently turned into stepping-stones in the street, and pieces of statues inserted into houses ; you occasionally stumble over a broken shaft, or you may hurt your shin against the corner of a votive altar, you may fancy you have found an inscription which is to throw light upon your topography, but approaching to read, it turns out to be a verse of the Koran, or Mahommed is his prophet. There is yet, however, much that an antiquary, if he had time and a pickaxe, might evolve out of “ the double night of ages and of ignorance ;” and perhaps this new sort of a column into which English, French and Turks are twisted now, may lead to some excavations that will bring to light a work of Phidias, or one of the Oboli dropped into the begging bag of Belisarius ! I did not profess, in offering this paper to the Institute, to attempt any account or description of the modern buildings of Stamboul, not for want of matter, but for want of time ; and in order to maintain a certain consistency with the heading of our conversazione ; but before I conclude this paper, I will venture upon two specimens of existing objects respectively belonging to the religion of Turks and Christians, I mean a Mosque and a Church. The Mosque of Sultan Achmet, erected in 1610, is doubtless one of the finest buildings the Turks ever produced, it is the only one that has six minarets. The Osmaneas, built by Osmyn III, is also worthy to be mentioned. The Validè, built by the mother of Mahomet IV, is another of the chief Turkish temples, but the Mosque I shall take as a specimen is the one I obtained access to, the Solimaneas. The Sultan, Soliman XIV. Emperor of the Turks, was fully entitled by the laws of the Koran to erect a temple, for he had subdued provinces in three out of the four quarters of the world, he was contemporary with Charles V, and struck terror into the European sovereigns. Returning from his conquests of Rhodes and Bagdat, he reared this stately Mosque, where the rules of Mahomedan architecture are strictly followed, it was mainly built out of the spoils of the ancient Chalcedon. A fine quadrangular court, like the cloister of a monastery in form, is supported by ancient columns of granite and porphyry, in the midst is the fountain for the religious ablutions of the Musselmans ; the whole magnitude of the interior is displayed to the eye of the stranger at his first entrance. There are no nefs or subdivisions to obstruct the full comprehension of the whole space enclosed. The dome, supported upon four splendid granite columns, covers the whole space on which we stand, and Pantheon-like gathers and eats up all the air around it. The lamps suspended and crossed in all directions, add as little to the simplicity and dignity of the interior, as the innumerable wax-lights and festoons of the Romans add to their Basilicas. On the side opposite the entrance are several stained glass windows, reported to have been done by some artists from Persia ; the colours are rich but generally much deeper than in

our cathedrals. The Keblè, or Caaba, is on the same side: here the chief Mufti says his prayers, on his left he has an elevated pulpit from which he expounds the Koran; opposite this is the seat of the Mollah; these are arranged as systematically as any of our modern Sedilia. On the right, but not conspicuous, is the Sultan's seat whenever he chooses to pray at the Solimanea; behind the pillars and in the recesses of the walls are seen the worshippers, some praying, and others reading the Koran aloud, copies of which, as our Bibles used to be in days of scarcity, are chained to the walls. We walk round the whole of the interior with shoeless feet upon smooth matting, the Caaba only is carpeted, and a Mollah keeps an eye upon the Giaours and their piastres, as they dare to violate this sanctuary of Ismalism. Near to this Mosque, in a garden, is the Mausoleum of Soliman and his relations, an octagonal building covered by a neat dome, but I must omit the detailed description. The number of Imperial Mosques are seven in all, a remarkable coincidence with the seven Basilicas of Rome; these (I mean the Mosques) are—

S. Sophia.	The Solimanea.
Sultan Mahomed.	Sultan Achmet.
Sultan Selim.	The Osmaynea.

and the Sultan Bajazet.

Except the one of Sultan Achmet, they have all four minarets each, and large groups of cupolas.

As the specimen of a christian place of worship I shall take the patriarchal church of St. George, which stands just within Petri Capoussi, a gate of the Fanar. In entering the court the visitor is seized with a shuddering fit, when he is told that he is passing under the beam to which the aged patriarch Gregory was suspended, in his pontifical robes, on Easter Sunday 1821. The Jews took his body, and with mockery and insult threw it into the canal, mutilated and bleeding. The thrilling effect which this inhuman murder produced throughout Christendom, contributed greatly to the Greek cause, which issued in independence. The interior of the cathedral boasts of no richness of material, but it is kept clean; there is a screen in better taste than in most of the Greek churches. They show the episcopal chair of burnished wood, which is said to be the cathedra of John Chrysostom, but this seems to be too much even for the credulity of an Asiatic Greek christian. The column to which they say the Saviour was bound, is held in greater veneration; the expounder did not seem to be aware that there were several others in the Latin part of the world: the frieze under the gallery is painted by some Italian artist, who, perhaps, followed in the steps of Bellini from Venice. A coarse mosaic of the Virgin, and some ordinary Greek paintings, decorate the walls around the inner sanctuary, and the gilding of the screen is perhaps the richest ornament the Oriental church possesses. This cathedral, for such we must call it, can accommodate 600 or 700 persons at one time, and it is the largest and best conditioned christian temple in Constantinople; close adjoining to it is the patriarch's dwelling, a remarkable contrast with the splendid palaces of his brother of the West, "The most Holy Anthemos" seemed to me to be more happy with one chamber to sleep in, and another in which to drink his coffee, than his more fortunate competitor for sacerdotal dominion, with eleven hundred chambers at the Vatican, and a palace at Castel Gandolfo. But here we pause. I dare not venture up the Bosphorus into the Black Sea, although there are many objects of classical interest which that excursion would afford. If the Peace Society should allow the war to go on for another of your sessions, I shall think it my duty to tell all I know of Beicos Bay, and the fortresses on both sides the stream, built by French engineers during the latter half of last century, perhaps for French artillery to knock down during the present. Constantinople has its Campagna as well as Rome, and the coast of the Euxine Sea is now becoming as celebrated as the Lavinian shores. We do not know what another year may bring forth, but some great change is inevitable, or "where the Russian Ksar

* * * * * or sultan in Bizance

Turchestan born."—(MILTON.)

It is still possible we may have an excavation in Constantinople, and a free admission for Franks into Santa Sophia. The patriarch may possibly get an additional wing to St. George, and the Crescent and the Cross may appear on the same standard which is to wave on the ruins of Sebastopol and avenge Sinope; "*sed nos hæc grandia haud conamur*," you will not be surprised to hear, "that the weapon which my Spirit yields is of another temper." I have more confidence in a Peace Society which was instituted eighteen centuries ago, and which has been waging war with the powers of evil ever since, but its legitimate weapons are not of steel, nor its artillery of brass and iron; it proposes to overcome, and finally to triumph, by the simple proclamation of "peace on earth and goodwill towards men," and I look forward to the sower going out to sow in peace when the battle of the warrior has ceased. The highway to the East will be made for all nations, and who knows but the Jews may dwell in their own land. The artist may make his cheap excursion in the same steamboat which will carry the biblical student to the land of Armenia; and the architect may still measure the columns which are concealed at Derbe and at Lystra, where the gods were supposed once to have come down in the likeness of men. The gates of Constantinople shall stand open to receive the civilising influences which always follow in the train of the christian missionary, witness New Zealand and Sierra Leone, and the regions round about Abbeokouta. A summer excursion will be more easily made than it was in 1834, when the humble individual who has now tried the patience of his audience, gathered up the materials which have enabled him to compile this paper, chiefly out of his own book, on the Topography and Antiquities of Constantinople.

Mr. T. H. WYATT, V.P., Chairman, proposed the thanks of the Institute to Mr. Burgess for his brilliant and learned paper, which had lost none of the grace and spirit of his former communications.

Mr. TITE, Fellow, entirely concurred in the eulogium of the chairman. He hoped, however, Mr. Burgess would not consider that he had communicated all his information respecting Constantinople, inasmuch as very little had been said about St. Sophia, and he hoped therefore the Institute might be favoured with another paper on that remarkable building, of which comparatively little was known in this country. The drawings of the Mahomedan buildings at Bejapoor, now exhibited by Colonel Sykes, were proofs of the skill of the Mahomedans as architects.* The style which they adopted was peculiar, and no doubt scientific. The same sentiment and mode of construction might be traced in Turkey, throughout the whole of India, and in the Alhambra.

Mr. DONALDSON, Hon. Sec. For. Cor., observed, that the mosque of St. Sophia was the work of Greek and not Mahomedan architects. It would be interesting to know the history of the other mosques at Constantinople, and whether they also owed their origin to Greek architects. Their simi-

* In reference to these drawings Mr. DONALDSON observed, that they were especially interesting, from the elaborate and careful manner in which they had been prepared, and as illustrations of the employment of colour and mosaics.

Colonel SYKES, Visitor, stated that the drawings referred to were due to the suggestion of a member of the Institute, Mr. Fergusson, who strongly urged the importance of having plans and sections of these buildings, especially of the great dome of the Gol Goomuz, the diameter of the lower octagon of which was no less than 135 feet. Orders were accordingly sent out to the government of Bombay, and, under the superintendence of Mr. Frere, the distinguished Commissioner of Scinde, who was a great lover of art, the seventy-four plans, elevations, and sections now submitted to the meeting had been prepared; and so accurately had this been done, that it would be quite practicable to reconstruct the buildings from these drawings alone. These buildings were erected by a dynasty (comprising five or six kings), which was put an end to by Aurungzebe, in the seventeenth century, and which had expended vast sums of money, and displayed great taste in architecture, as the Mahomedans always did. The beauty and harmony of the colouring in these works, was especially characteristic and remarkable. In reply to Mr. TITE, Colonel SYKES added, that the buildings in question were constructed of brick and slate, the latter admitting of a durable polish. The surrounding country was flat, and whatever stone was used, had to be brought from a considerable distance. Hitherto it had been presumed that no marble adapted for building or statuary was to be met with in India, but from intelligence received by the last mail, it appeared that through the energy and zeal of the gentleman in charge of the museum of mineralogy at Madras, some very fine marble had been discovered in many districts. Colonel SYKES briefly described the composition of the chunam (so called) or stucco forming the surface of the walls.

larity of plan rather favoured this idea; but it was a question well deserving study, how far the Turks had departed from that type and added new features to it. Signor Fossati, who had been employed to restore the mosque of St. Sophia, had published an instructive illustrative work on that building. And this study would be further facilitated by an important work, now in course of publication at Berlin by Salzenberg, a German architect, who had been sent out on purpose to examine, and take plans and details of the Greek churches of Constantinople.

Mr. BURGESS stated, that he had never been inside the mosque of St. Sophia, to which admission was not obtained without much greater difficulty than in the case of other mosques. He believed that all the Turkish mosques were built upon the plan of St. Sophia. He had visited one at Adrianople, which corresponded exactly with that of Solimanea, which he had described.

Mr. ALFRED BAILEY, Associate, said that, having been very recently in Constantinople, he was able to state that the bigotry against Christians, which formerly existed, was very much diminished. He had himself been in at least three dozen mosques, and never found any difficulty in obtaining the necessary firman, with the aid of a few piastres. In the autumn of 1852, when he was at Constantinople, a fire took place adjoining the Hippodrome, which exposed to view an immense circular wall, which had been taken for a theatre, but which at all events proved that the Hippodrome had formerly occupied a much larger space than at present. He might observe that one of the heads of the serpents forming the twisted column of bronze (referred to by Mr. Burgess), was preserved in the Museum of the Armoury, and that in one of the outbuildings of the church of St. George a museum had been formed, in which a number of sarcophagi and other objects of antiquity were preserved; although from their religious creed, which regarded as an abomination all representations of the living form, an immense number of monuments had been destroyed by the Turks. It was to be regretted that the church of St. Sophia, like other Byzantine works, had been disfigured, first by a coat of compo, and then by a coat of yellow wash. Upon the whole there could not be a doubt that the architects of Constantinople, who had produced such magnificent mosques, fountains, &c., were decidedly great artists, and had left some equivalent for the older works which they had destroyed.

Mr. PAPWORTH, Fellow, suggested that it appeared from the best authorities, that the Mahomedan princes and nobles, not only in former times but to this day, employed Armenian christians as the architects and builders of their mosques and temples; and that this might have been the case in Constantinople, in Egypt, in Syria, and even in the north of India, on the confines of Persia.

Colonel SYKES said that this was not the fact in India.

The thanks of the meeting were unanimously voted to the Rev. Mr. Burgess, and the proceedings of the Session terminated.

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